SABARMTI RIVERFRONT DEVELOPMENT

Sabarmati River Front Development Corporation Limited

2nd Floor, Riverfront House,
B/h H.K Arts College,
Between Gandhi Bridge and Nehru Bridge,
Pujya Pramukh swami Marg
(River Front Road-West)
Ahmedabad-380009

BID DOCUMENT

CONSTRUCTION OF PUBLIC PLAZA AND UNDERGROUND PARKING FACILITY AT SANSKAR KENDRA - TAGORE HALL CAMPUS CONNECTING RIVERFRONT FOR SRFDCL.

Contract Package : SRFDCL

VOLUME-02

IV) Technical Specification-Electrical &ELV

SPECIAL CONDITIONS OF CONTRACT

A GENERAL:

These special conditions are meant to amplify the specifications and General Conditions of Contract. If any discrepancy is noticed between General Conditions of contract, specification, Bill of Quantity and Drawings, the most stringent of the above shall apply.

The scope of this section is to describe materials and systems for electrical installation of building which form together with the project documents, a complete volume of work and quality description.

All electrical installations shall be of high quality, safe, complete and fully operational including all necessary items and accessories whether or not specified in detail. All electrical works shall be completed in accordance with the regulations and standard to the specification OWNER, the general provisions, special provisions and general requirements apply to all items of this specification.

The work shall be carried out simultaneously with building work, civil work, etc. and shall be continued till it is completed satisfactorily along with the completion of essential portions of the building works.

During the progress of work, completed portion of the building may be occupied and be put to use by OWNER but the contractor will remain fully responsible for the maintenance of electrical installations till the entire work covered by this contract is satisfactorily completed by him and handed over to OWNER.

B ACCOMPANIMENT TO TENDER:

The tenderer will attach to the Tender, at the time of submission, a statement containing information on the following points on separate proforma:

List of all the confirmation of materials to be used as per specification along with manufacturer's name, catalogue and other technical details. Any deviation from the specifications shall be separately pointed out.

C TENDER RATES:

The rates shall be quoted for each item for units mentioned in Bill of quantity against each item. The rates quoted by the Tenderer shall include charges for bringing in transport, hoisting, loading and unloading at the and from the site of works. The tender rate quoted for each item for units/quantities in BOQ shall allow for sales tax on works contract, octroi, Excise, S.T. and any other government levies/duties etc. as specified in the general conditions of contract.

The rate shall be inclusive of all taxes, costs, levies, duties, octroi, labour charges, or any other duties, levied by the Government or to be paid to the local authorities. The rate shall also be inclusive of scaffolding, hire of tools and plants, drilling and chiselling holes, grooves in wall, concrete, masonry etc. and making them good.

D INTENT:

It is the intention of the specification and drawings to call for finished work, tested and ready for operation. Whenever the words "Supply" or "Provide" are used, it shall mean delivery of material as specified in an assembled manner, ready for installation. Any apparatus, material or work not shown on drawings but mentioned in the specification or vice versa, or any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation, even if not particularly specified, shall be furnished, delivered and installed by the contractor without additional expenses to

OWNER. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work and in the contract.

E INTERPRETATION OF PROJECT DOCUMENTS:

a) The Specification, Drawings, and Bill of quantity shall be interpreted in accordance with good installation practice defined in the appropriate regulations and standards whether specifically referred to or not. If there is any discrepancy or shortfall in the application of the regulations to any aspect of this contract or the contractor considers there is anything detrimental to the standards or inconsistent with his obligations and guarantees, OWNER shall be informed prior to signing the contract and shall thereafter inform the contractor in writing the course to be followed. Where the drawings are to a small scale or are expressed in symbolic terms or are in the form of a diagram, then exact location of items shall not be inferred and in all cases, the work shall be fully integrated with the work of other trades and with the fabric of the building. The contractor shall appraise the duties of all plants and equipment taking account of any additions or variations and shall inform the OWNER of any matters which may affect the design. In all cases the equipment installed shall be of appropriate rating for the duty it performs.

b) The Specifications and Bill of quantity shall be considered as part of this contract and any work or material shown on BOQ and not called for in the specification or vice versa, shall be executed as if specifically called for in both. The Drawings indicate the extent and general arrangement of the Electrical Equipment Layout etc. and are essentially diagrammatic.

The work shall be installed as indicated on the drawings, however, any minor changes found essential to coordinate the installations of this work with other services shall be made without any additional cost to the owner. The drawings are for the guidance of the contractor, exact locations, distances and levels will be governed by the building. The contractor shall examine all structural and electrical drawings before starting the work, and report to OWNER or its representative, any discrepancies which in his opinion appear on them, and get them clarified.

F SCOPE OF WORK:

a) The work to be carried out under this contract comprises of the Electrical Installation work for the proposed project called for in the documents. The work covered under this contract comprises of supply (wherever called for), installation, connection, testing and commissioning the Electrical installation commencing from point of electric power supply within the project site as per specifications, relevant Indian standards, Code of practice.

The contractor shall carry out and complete the said work under this contract in every respect in conformity with the current rules and regulations of the local Electricity Authority, the Indian Standards and with the directions of and to the satisfaction of the Consultant/PMC and owner. The Contractor shall furnish all labour and install all materials, appliances, equipment (except those items which will be supplied by the Owner to the contractor at site), necessary for complete provision and testing of the whole electrical installation as specified herein and shown on the drawings. This also includes any material, appliances, equipment not specifically mentioned herein or noted on the drawing as being furnished or installed but which are necessary and customary to make complete installation with all outlets for power, light, telephone conduits, all other conduits and other electrical systems shown in the schedule or described herein, properly connected and in working order.

The work shall include all incidental jobs connected with electrical installation such as excavation for trenches and back filing, cutting/drilling holes through walls/floors and grouting for fixing of fixtures, equipment etc. Chiselling in the wall or principal structure

is not permitted. In general, the work to be performed under this contract shall comprise of the following: -

i. Substation comprising of
ii. Connection/Synchronization with D. G. set (Supplied and installed under separate package.
iii. Substation accessories
iv. Earthing
v. L.T panels
vi. Connection to HVAC plant panel (Panel by HVAC Contractor)
vii. Lighting distribution board (LDB)
viii. Earthing and lightning protection system installation
ix. Plate / Pipe electrode type earth station
x. Earth continuity conductor
xi. Internal and external lighting with fixtures
xii. UPS/Stabilizer cabling/wiring

b) All qualities mentioned in the Bill of quantity are approximate and the contractor shall not be eligible for any claim due to any variation in / or omission of any item.

c) Any extra item shall be calculated on the rate analysis basis approved by OWNER.

d) It is the responsibility of the contractor to co-ordinate with State Electricity Board. / Electrical Inspector and fulfil all the requirements of State Electricity Board. at no extra cost and arrange for the power connection.

G ABBREVIATIONS:

The following abbreviations have been used in the accompanying specifications, drawings, and Bill of quantity:

ISS : Indian Standard Specifications.
HRC : High Rupturing Capacity.
GI : Galvanized Iron.
MS : Mild Steel.
MV : Medium Voltage.
LV : Low Voltage.
PVC : Polyvinyl Chloride.
AMP : Amperes.
V : Volts.
KV : Kilo Volts.
HV : High Voltage
KW : Kilo Watt
KVA : Kilo Volt Ampere
PF : Power Factor
Hz : Frequency
KWH : Kilo Watt Hour
XLPE : Cross Linked Polyethylene
ACB : Air Circuit Breaker
LED : Light Emitting diode
PLC : Programmable Logic Controller
UPS : Uninterrupted Power Supply
DP : Double Phase
IEE : Institute of Electrical Engineers, London.
MCB : Miniature Circuit Breaker.
TPN : Triple pole and Neutral.
SP : Single Pole.
MCCB : Moulded case Circuit breaker.
VCB : Vacuum circuit breaker.

CT : Current transformer.
DB : Distribution board.
DG : Diesel generator.
BOQ : Bill of quantity.
SITC : Supply, installation, testing and commissioning.
L.O.I. : Letter of intent/Acceptance letter.

H REGULATIONS AND STANDARDS:

The installation shall conform in all respects to Indian standard code of Practice for Electrical Wiring installation IS: 732-1963 and IS: 2214-1963 (Silver Nitrate Pure and analytical reagent). It shall also be in conformity with the current Indian Electricity Rules, Indian Electricity Act, National Electrical Code and Regulations of the Local Electrical supply Authority in so far as these become applicable to the installation. Wherever this specification calls for a higher standard of material and/or workmanship than those required by any of the above regulations then this specification shall take precedence over the said regulations and standard. In general, the materials equipment and workmanship not covered by the above shall conform to the relevant Indian Standards.

The electrical installation work shall follow Codes, Indian standard specifications, and rules (Within the best meaning of the same) under this contract.

The following list is given for general guidance only in addition to list given in each individual section, however all other latest editions of Codes, Indian standard specifications and Rules shall also be followed when it is required.

I.S. : 8623 Low voltage switchgear & control gear assemblies.

I.S. : 10118 Code of practice for selection, installation and maintenance of switchgear and control gear.

I.S. : 4237 General requirement for switch gear and control gear for voltage not exceeding 1000 Volt a.c. or 1200 volts d.c.

I.S. : 13947 Low voltage switchgear and control gear.

I.S. : 9224 Low voltage fuses.

I.S. : 8828 Circuit breakers for out protection for household and similar installations.

I.S. : 12640 Earth leakage circuit breaker.

I.S. : 1248 Direct acting indicating analog electrical measuring instruments

I.S. : 2705 Current transformers.

I.S. : 4201 Application guide for voltage transformers.

I.S. : 6875 Control switches for voltage upto and indicating 1000V a.c. 1200 V d.c.

I.S. : 5578 Guide for marking of insulated conductors.

I.S. : 11353 Guide for uniform system of marking and identification of conductors and apparatus transmission.

I.S. : 8197 Terminal markings for electrical measuring instruments and their accessories.

I.S. : 694 Specifications for PVC insulated cables for working voltages up to and including 1100 volts.

I.S. : 2551 Danger notice plates.

I.S. : 3043 Code of practice for earthing.

I.S. : 5216 Guide for safety procedures and practices in electrical work.

I.S. : 1646 Code of practice for fire safety of building : Electrical installation.

Indian Electricity Act as amended up to date.

Rules and Regulations of Bombay Regional Council of Fire Insurance & Association of India for Electrical wiring or local equivalent.

I FEES, PERMITS AND TESTS:

The Contractor shall pay for any and all fees and obtain permits required for the installation work. On completion of the work the contractor shall obtain and deliver to the OWNER, certificates of final inspection and approval by the local electric supply authority and the electrical inspector.

J UTILITY SUPPLY:

The location of receipt of incoming utilities supply (Hook up Points) like HT power supply, it is the responsibility of the contractor to co-ordinate with various utility agencies, the exact location of such Hook up Point and mode of connection. Further the contractor shall co-ordinate with such utility agencies to provide necessary drawings, documents, get their approval, make the necessary arrangement for the payments and arrange the utilities supply at no extra cost.

K ACTUAL ROUTE OF PIPING:

The location of the AHU, FCUs, Chillers, Chilled water pumps, Cooling Towers and CHW and Cooling water piping etc. are indicative only, therefore, the actual route of piping and the location may differ from the plans according to the details of the building construction and the conditions of executions of the installations.

The contractor shall supply and install at his expense all secondary materials and special fittings found necessary to overcome the interference and to supply the modifications on the route of ref. piping that are found necessary during the work, to the complete satisfaction of the owner's representative.

L MATERIAL AND EQUIPMENT:

All material and equipment shall conform to the relevant standards and shall be of the approved make and design. The materials and equipment shall conform to relevant Indian Standards. The Contractor shall be responsible for the safe custody of all the materials and shall insure them against theft, damage by fire, earthquake etc. A list of items of materials and equipment, together with sample of each shall be submitted to the OWNER within 10 days of the award of the contract. Any item which is proposed as a substitute, shall be accompanied by all technical detail giving sizes, particulars of materials and the manufacturer's name and shall be submitted along with the tender or bid offer. At the time of the submission of proposed substitute the Contractor shall state the credit, if any due to the owner. In the event the substitution is approved, all changes and substitutions shall be requested in writing and approvals obtained in writing from OWNER. OWNER's decision in the matter shall be final.

All materials of the same kind of service shall be identical and made by the same manufacturers. Any deviation to this rule shall be approved by the Consultant. Top priority

shall be given to the products that have a permanent agent providing spare parts and maintenance facilities in the same city where the project is situated.

The make of electrical equipment, components, accessories, etc. has been mentioned in order of priorities. The tenderer has to quote for the first priority as mentioned above after ascertaining that the first preference materials are available. If at a later stage during executing the work, material of the first preference make are not available, the contractor has to get approval from the OWNER to use other make of material prior to procurement. Any rate difference for the first preference make and the one approved will be passed on to the owner.

M MANUFACTURERS :

Where manufacturers have furnished specific instructions relating to the materials used in this job, covering points not specifically mentioned in these documents, these instructions shall be followed in all cases.

Where manufacturer's names and/or catalogue numbers are given, this is an indication of the quality, standards and performance required.
When interfacing occurs, equipment shall be mutually compatible in all respects.

N RATING:

Rating of all items shall be appropriate for the conditions on the particular site on which the items will be used. All the equipment shall be fit for continuous work under the worst conditions of site and shall be rated for the following ambient condition.

- Outdoor temperature 45 deg. cel.
- Temperature under shed 40 deg. cel.
- Salty, dusty and humid

O INSPECTION AND TESTING:

OWNER'S representative reserves the right to request inspection and testing of the manufacturer's works at all reasonable times during manufacture of items for this contract. Tests on site of completed works shall demonstrate, among other things:

a. That the equipment installed complies with specifications in all particulars and is of the correct rating for the duty and site conditions.

b. That all items operate efficiently and quietly to meet the specified requirements.

c. That all the features performed at its best and loading _unloading of the system.

d. That all the accessories used in low side work are of specified make only. And any deviation in the same needs written approval from our technical consultant.

The contractor shall provide all necessary instruments and labor for testing, shall make adequate records of test procedures and readings, shall repeat any tests requested by the OWNER and shall provide test certificates signed by a properly authorized person. Such test certificates shall cover all works.

If tests fail to demonstrate the satisfactory nature of the installation or any part thereof then no claims for the extra cost of modifications, replacements or retesting will be considered. OWNER's decision as to what constitutes a satisfactory test shall be final.

The above general requirements as to testing shall be read in conjunction with any particular requirements specified elsewhere.

P PRICE DETAILS:

At anytime and at the request of OWNER, the contract shall provide details or breakdown of costs and prices of any part or parts of the works.

Q TEST CERTIFICATES:

The contractor shall submit test certificates for all the electrical material/system installed. These shall be issued by a government recognized inspection office certifying that all equipment, materials, construction and functions are in agreement with the requirements of these specifications, ISI and when ISI is not applicable other approved certifying agencies.

R INSTRUCTION MANUAL:

The contractor shall prepare and produce instruction, operation and maintenance manuals in English for the use, operation and maintenance of the supplied equipment and installations, and submit 3 sets to OWNER, at the time of handing over.

S SAMPLES AND CATALOGUES:

Before ordering the material necessary for these installations, the contractor shall submit to OWNER for approval, a sample of every kind of material such as cables, conductors, conduits, switches, socket outlets, circuit breakers, lighting fixtures, boxes etc., along with the catalogues.

For big items such as switchboards, the submission of catalogues shall be enough. Prior to ordering any electrical equipment/material/system, the contractor shall submit to OWNER, the catalogues, along with the samples, at least from three different manufacturers. After the selection of manufacturer by OWNER, the contractor shall arrange inspection and testing at the manufacturer's factory or assembly shop for final approval. No material shall be procured prior to the approval of the OWNER.

T VENDOR AND SHOP DRAWINGS:

The contractor shall prepare and submit to PMC/Consultant/OWNER, for his approval, two sets of vendor detailed drawings of all distribution boards, switch boards, outlet boxes, special pull boxes, and other likewise material, equipment to be fabricated by the contractor, or other vendor within 15 days of signing of the contract.

Before starting the work, the contractor shall submit to PMC/Consultant/OWNER for his approval in the prescribed manner, the shop/execution drawings for the entire installation, especially the main connections and junctions, the route of conduits and cables, no. and size of wires drawn through the conduits, location of all the outlet points, and switch boards and distribution boards and any other information required by OWNER. OWNER reserves the right to alter or modify these drawings if they are found to be insufficient or not complying with the established technical standards or if they do not offer the most satisfactory performance or accessibility for maintenance.

U AS BUILT DRAWINGS:

At the completion of work and before issuance of certificate of virtual completion the contractor shall submit to OWNER, three sets of layout drawing drawn at appropriate scale indicating the complete wiring system "as installed" duly approved by Consultant/PMC. These drawings must provide (in plan, folded elevation and section)

a. Location and details of distribution boards, main switches, switchgear and other particulars

b. Location of all earthing stations, route and size of all earthing conductors, manholes etc..
c. Route and particulars of all cables.
d. Lighting layout plan for all the floors alongwith circuit distribution details
e. External Area Lighting Plan

V GUARANTEE:

At the close of the work and before issuance of final certificate of virtual completion by OWNER, the contractor shall furnish written guarantee indemnifying OWNER against defective materials and workmanship for a period of one year after completion. The contractor shall hold himself fully responsible for reinstallation or replacement, free of cost to OWNER, the following:

a. Any defective work or material supplied by the contractor.

b. Any material or equipment supplied by OWNER which is damaged or destroyed as a result of defective workmanship by the contractor.

c. Any material or equipment damaged or destroyed as a result of defective workmanship by the contractor.

d. Contractor shall operate the system for 48 months from the date of commissioning and train the client's staff for operation and routine in house maintenance.

e. The Contractor shall arrange for inspection of Compact Substation and LT Panel and all other equipment (as per client's requirement) in the presence of Client, PMC and Consultant Team at OEM Factory. All expenses related to inspection shall be borne by the Contractor.

W SAFETY OF MATERIALS:

The contractor shall provide proper and adequate, storage facilities to protect all the materials and equipment including those issued by OWNER against damage from any cause whatsoever.

X COMPLETION CERTIFICATE:

On completion of the electrical installation (or an extension to an installation) a certificate shall be furnished by the contractor countersigned by the licensed supervisor, under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local supply authority. The contractor shall be responsible for getting the electrical installation inspected and approved by the local concerned authorities.

Y DEFECTS LIABILITY:

Defects liability period shall mean 12 calendar months after OWNER have issued certificate of completion of the whole work. The certificate of completion shall be issued after the necessary tests have been carried out to the satisfaction of OWNER and the required drawings are submitted.

The contractor shall make good at his own cost and to the satisfaction of OWNER, all defects or other faults arising in the opinion of OWNER out of bad workmanship or faulty materials not in accordance with the drawings, ASHRAE Standard under which it may appear within twelve months after completion of the work.

Z SITE ENGINEER AND TRAINING:

The contractor shall employ a competent fully licensed qualified, full time Electrical engineer to direct the work of Electrical installation in accordance with the drawings and specifications. The engineer shall be available all times at site to receive instructions from OWNER, in the day-to-day activities throughout the duration of contract. The engineer shall correlate the progress of the work in conjunction with all the relevant requirements of the supply authority. The engineer coordinates with other services contractor and PMC for any coordination site issues.

Contractor shall give training to technical staff of client for Operating, Control and Basic maintenance for easy operation.

AA LIASIONING WITH LOCAL SUPPLY COMPANY

The contractor shall be responsible for all the liasioning work with the supply company. However, all the technical assistance required for the same may be furnished by the consultant. The contractor has to fill the necessary forms and submit test reports so as to ensure that the supply is available in time. The contractor shall prepare necessary drawings for the approval of the concern government departments.

BB RESTATING & FINISHING OF CIVIL DAMAGES:

For erection of equipment / Piping / Ducting etc., if any civil structure is required to be broken, the same shall be done, restated and finished as original by the tenderer without any extra cost

CC MAINTENANCE SCHEDULE:

1) To operate and maintain: Compact substation, incoming and outgoing LT panels, Switch gear, feeder panels, feeder switchboards, associated protection equipment's, HT and LT cables, control cables, battery charges, capacitor panels/power factor correction panels, pump panels, HVAC panels, Earthing of Substation and buildings such that the earth resistance shall be maintained with permissible limits, Lightning protection system of buildings such that earth resistance shall be maintained with permissible limits etc. and their associated component etc. round the clock throughout the year.
2) To monitor & record the incoming supply parameters, make necessary tap changing to maintain the voltage in limits, maintain the power factor at not less than 0.96 lagging by switching the capacitor banks, to keep the maximum demand within prescribed limits etc.
3) To check earth pits pertaining to all equipment's, systems and buildings etc. and testing their earth resistance etc. To check the transformers parameters and cooling systems for leakage of transformer oil and topping up of the same as and when required.
4) To check/clean / tighten all electrical contacts monthly. The heated terminals if required to be made in proper condition by using appropriate size crimping tool and lugs.
5) To check and replace, if necessary, the performance of all operational safeties. This activity must be done at least once in three months and if required earlier too.
6) To check electrical circuits within Panels & DBs and rectify faults as and when necessary.
7) To replace electrical contacts and other items as and when required.
8) To ensure that the control circuitry of all systems is perfectly working.
9) To check the silica gel of the transformers and to dry them as and when required.

10) To test the oil samples of transformers and to give suggestions for dehydration of oil if required.

11) To arrange for a well-equipped first-aid box and maintain it in a healthy condition to take care of first aid for any eventualities of their workman at site.

12) Arrange all type of repairs, spares & consumables required for proper working of electrical installations.

13) Any other electrical works as assigned by the engineer in charge essentially required for keeping the equipment's in good healthy working conditions though not indicated above.

14) Yearly servicing of ACB, VCB, all relay, calibration of meters and providing report for the same.

15) Quarterly visually inspect UPS for loose connections, burned insulation or any other signs of wear.

16) Semi-annually, visually check for liquid contamination from batteries and capacitors. It needs to be replaced as and when require.

17) Clean and vacuum UPS equipment enclosures.

18) Check all light fixtures and its components and replace it as and when require.

19) Any other component or item not listed here or in contract, but it will require to install during the execution stage shall also be part of O & M.

20) For Lift provide 6 routine service and 3 safety inspection per year.

DD Fire Alarm and Detection System

1) Comprehensive Maintenance for fire detection and alarm system installed at various locations
2) The contract shall include minimum one general service initially and subsequent fortnightly checking & submission of report
3) The contractor needs to depute experienced mechanic at site fortnightly, but all complaints/repairs shall be attended to within 24 hours, failing which the contractor will be required to provide requisite number of standby fire extinguishers at his own expenses.
4) If urgent work is required on Sunday or a public holiday, contractor shall be duly intimated by the office, and it will be incumbent upon the contractor to carry the work on such Public Holidays.

   Routine Service (Fortnightly)

   For maintenance of Smoke detection system.
   - General cleaning.
   - Detector communication test and checking of alarm system.
   - Battery power test.
   - Smoke detection test.
   - Emergency light test etc.

All complaints/repairs will be resolved within 24 hours, if there is delay in attending and resolving the complaint, the contractor will be fined Rs. 1000 per day.

GENERAL TECHNICAL SPECIFICATION FOR ELECTRICAL WORK

1.0 DIESEL GENERATOR SET

1.1 General:

1.1.1 Scope:

This general specification together with the equipment sheets and attachments defines the minimum requirements the design, performance, inspection, testing and supply diesel engines for general industrial purposes.

The construction, design and rating of the diesel engine shall meet fully, the requirements of the specified driven machine and the Vendor shall select and provide the requisite ancillaries and controls with the diesel engine for its safe and satisfactory operation.

No deviations or exceptions from this specification shall be permitted without the written approval of the purchaser. Intended deviations supported by reasons there of shall be separately listed by the vendor and submitted with the bid for the consideration of the Purchaser.

Compliance with this specification shall not relieve the vendor of the responsibility of furnishing equipment and accessories of proper design, materials and workmanship to meet the specified operating conditions.

This general specification supplements the specific requirements contained in the attached equipment data sheets. In the event of any contradiction between the two, the information contained in the latter shall govern.

Other attachments of the Material Requisition from a apart of this specification.

1.1.2 Terms and Definitions:

The Net Calorific value of fuel is defined as the heat resulting from the complete combustion of a unit quantity of fuel oil and air, without condensation of the water vapor. A net calorific value of 9,720 Kcal/Kg (As per IS : 1460 Rev.2) shall be considered while declaring the fuel consumption and for testing purposes.

The unit of horse power as defined in this specification is the metric horse power equivalent to 4,500 n-Kg/Min. The horse power in F.P.S. system is equal to 1.014 metric horse power.

Other terms used in this specification or in the equipment data sheets are as defined in the latest edition of British Standard-5514.

1.1.3 Standard Operating Conditions:

The standard operating conditions shall be defined in the latest edition of B.S.-5514 unless otherwise mentioned specifically in the equipment data sheet.

1.1.4 Rated Power output and speed:

The diesel engine rating shall be the net output in brake horse power, which the engine is capable of delivering continuously at the stated crank shaft speed under the conditions specified under Clause 2.0 above, provided the engine is maintained in good operating condition and is serviced / overhauled regularly as per the schedules laid down by the Manufacturer.

No negative tolerance shall be allowed on the diesel engine rating specified by the Vendor in the equipment data sheets.

The engine shall be capable of satisfactorily providing an output 10 percent in excess of the continuous rating defined as per IS 8582.

The normal power requirement of the engine driven radiator fan or the coolant pump and the battery charging dynamo shall be clearly stated for the engine which is so equipped.

Unless otherwise specified in the equipment data sheets, the site rating of the engine shall be worked out considering the duration's specified under the latest edition of B.S.-5514 and the power absorb by all the engine driven ancillaries shall also be deducted.

1.2 Design & Construction:

1.2.1 General:

The Diesel engine offered shall be of the regular production models of the manufacturer for industrial applications and already type tested either at the manufacturer's works or outside. The type test report shall be furnished to the purchaser for his review if so desired.

The diesel engine with less number of cylinders viz inline 6 / 8 cylinder arrangement will be preferred. The diesel engine should be latest design, without any PT pump, and it should be digital governing system to manage the fuel . The fuel system should be equip with unit injectors for better fuel automiztion .

Unless otherwise specified in the equipment data sheets, the diesel engine shall be provided with class A1 governing as per the latest edition of B.S. 5514.

The "Cyclic irregularity" of the diesel engine for direct coupling to an electric generator, "angular deviation of p73 A.C. generators " driven by diesel engine for parallel operation, and the "engine governor speed droop characteristics ", shall be restricted to the values specified under the latest edition of B.S.-5514.

In case diesel engines are required to drive generators in parallel, the governor fuel injection pumps provided should have identical characteristics and the speed-load curves shall be made available to the purchaser's inspector for his scrutiny and approval prior to load testing. The vendor shall maintain proper record for such curves to ensure additional diesel engines if required in future with identical characteristics, could be made available to the purchaser. A set of the said curves shall also be furnished to the purchaser.

The vendor shall be responsible for carrying out torsion analysis of the dynamic system as specified in the latest edition of British Standard-5514. The results in the fork of a report shall be submitted to the purchaser for scrutiny and reference, if desired.

Vendor shall provide the flexible exhaust connection /s to connect the engine exhaust to the exhaust piping. The required size of the exhaust piping should be clearly specified by the Vendor.

If specified, the common base plate for mounting the diesel engine and the driven equipment through single bearing alternator shall be supplied by the vendor.

Vendor shall indicate in the bid, the ISO Noise Level rating of the diesel engine with the offered exhaust silencer/s.

1.2.2 Engine Starting:

Diesel engines shall be capable of starting without the use of cold starting aids so long the ambient temperature at the site is not below 4 oC. The vendor shall provide suitable cold starting aids with diesel engine for quick starting below 4oC of ambient and such aids shall be clearly detailed out along with the offer.

Where the diesel engine is specified / offered with battery starting arrangement, the starter motor shall be capable of starting the engine without having to disengage the driven machine with the help of a clutch.

In case of diesel engines driving fire water pumps, besides the engine mounted dynamo and voltage regulator, the Vendor shall also provide automatic battery charging equipment suitable for taking power from an alternating current power source and mounted on a free-standing type of a panel.

The battery charger if specified in the equipment data sheet, shall be SMPS type.

Where the diesel engine is specified / offered with 24V Electric Start system.

If as specified in the data sheets, the diesel engine is required to start / stop automatically, the vendor shall provide the necessary controls (automatic-cum-manual) in the engine panel and the interconnecting wiring and piping from the panel to the engine and starting equipment. A pilot lamp shall be provided in the lineside of the starting equipment circuit to indicate that the controller is in the automatic position. In the event the engine does not start after three attempts have been made, the controller shall stop all further cranking and operate the audiovisual alarm.

ENGINE COOLING :

Radiator cooled engines are offered, the diesel engine shall be provided with a radiator for mounting on the common base plate, complete with the suction / blower fan, temperature control valve and a radiator guard.

1.2.3 Engine Fuel System :

The daily service fuel tank shall be equipped with as air breather, shielded level gauge, strainer and a hand hole, besides the required fuel connections and a drain plug. The capacity of tank shall be as specified in the equipment data sheets.

The inside surfaces of the fuel tank and the float tank shall be coated with Enamel Red or Black of I.C.I. or its equivalent and the outside surface to be given two coats of the oil resistant primer paint. Both the fuel tank and the float tank, shall be hydrostatic tested at a pressure not less than 0.35 kg /Cm2.

1.3 Inspection & Testing:

The inspector representing Purchaser shall have entry to the plant while and wherever work for the equipment is being performed.

The vendor shall have the responsibility of providing purchaser's inspector with all requisite facilities / equipment for carrying out satisfactory testing.

The diesel engines shall be tested in the presence of purchaser's inspector in accordance with the latest edition of B.S. -5514 or any other equivalent standard as agreed to with the purchaser before the finalization of order.

Unless otherwise specified, 10% overload provision shall be kept while setting the fuel stop for the site running.

The hydrostatic test certificates for the heat exchanger / intercoler , fuel tanks and other pressure vessels shall be furnished to the purchaser's inspector for his review and approval at the time of load testing of the diesel engine.

The engine control panel/s after assembly and wiring, shall be functionally tested in the presence of the purchaser's inspector.

Following tests has to be perform

PERFORMANCE TESTS

The schedule of tests to be performed in the Factory Acceptance Test shall include the following:

On each of three separate days and before any other operation of the diesel-alternator on that day three successful manual start-up operations to be accomplished.

Three separate manual start-up operations each within one minute of the diesel-alternator being shut down after running continuously for not less than one hour and attaining normal engine running temperatures.

Three separate automatic start-up operations with simulation of "mains failure". In all or any of these tests the diesel-alternator may be out on load by the automatic closing of the emergency power supply circuit breaker.

Three separate automatic shutdown operations, each initiated by mechanical simulation of a "low pressure" condition.

Three separate automatic shutdown operations, each initiated by manual instigation of an "over-speed" condition.

Three separate abortive start-up operations, each inducing "failure to start" shut-down.

The load tests shall be carried out at manufacturer's works as follows before dispatch:

Idle Run	-	05 mins
25% Load	-	15 mins
50% Load	-	30 mins
75% Load	-	30 mins
100% Load	-	60 mins
110% Load	-	60 mins

At the completion of the test, readings shall be taken of Voltage, Frequency, Current, Temperature, Vibration, Fuel ratio to Unit produced, Flue analysis and the following:

Insulation resistance – rotor, stator, exciter – to earth;

Insulation resistance – between stator windings;

Alternator rotor and exciter armature temperature

Noise level measurement of DG set in acoustic enclosure as per specification Vadild Test certificates of alternator manufacturer to be offered .

Site Test

Upon the delivery to the site and if the generator set is required to re-assemble on site, similar tests shall be carried out by the Contractor to ensure that the performance is not degraded.

The tests, but not limited to are:

- Diesel engine-Generator coupling and shafts alignment.

- On load 'mains failure' simulation test
- Safety devices test
- Remote monitoring
- Auxiliary contacts etc.
- Load tests.
- BMS interface test
- Load tests shall be carried out through building load (minimum 50%).

Additional Load test at any load other than building load or 100% load at site shall be optional which shall be quoted separately and will be decided by the Client. Cost to arrange the load bank for purpose of testing at site shall be included in the this separately quoted rate. Please delete this paragraph

1.4 Preparation for Shipment:

Immediately upon completion of all tests and inspections, all exposed machined surfaces shall be cleaned and coated with suitable rust preventive by the vendor and the unmachined surface shall be painted by at least two coats of red oxide primer.

Diesel engines shall be transported assembled as far as possible.

All untapped opening shall be provided with 4mm thick metal closures with full rubber gaskets and bolted by not less than 4 bolts. All connections including those for instruments, instrument leads, lubricating oil and the like shall be identified with securely attached tags indicating the type of connection, the instrument or the line description as applicable.

The equipment shall be crated for domestic / export shipment as specified in the data sheets considering for storage at job site for at least 6 months if specified at the time of placing order. Lifting load-out, and handling instructions shall be securely attached to the exterior of the largest packing in a well marked weather proof container. Upright position lifting points, weight (including packing and dimensions shall be clearly identified with item no., serial no., package no., and the names of the equipment.)

1.5 Proposal:

Proposals shall be accompanied with completely filled in Data Sheets. The vendor shall not use his own data sheets.

The proposals must include either a specified statement that all equipment is in accordance with the purchaser's specifications or exceptions, if any, to this general specification including attachments shall be clearly brought out by the vendor on separate sheets, supported with suitable reasons thereof for the consideration of the purchaser.

Additions or exclusions from the scope of supply shall be clearly brought out on separate sheets giving reasons for such deviations for the purchaser's approval.

The drawings and data as listed under "prints with Quote" on the vendor data requirement sheet attached with this specification, shall be provided.

The vendor shall also submit a separate proposal for carrying out supervision of the installation and commissioning of diesel engine/s offered indicating per item rates, no. of specialists proposed to be deputed, completion time and a list indicating nature and quantity of consumable/ tools required and any other terms.

1.6 Scope:

This specification define the requirements of design, manufacture, testing and supply of self excited emergency generator complete with automatic voltage regulator, control panel, generator breaker and other accessories as specified in the material requisition.

Unless otherwise specified the emergency generator shall be supplied complete with

a) Brushless excitation system complete with AVR.

b) Air inlet and outlet for generator cooling (inlet shall be oriented to suit local plant layout).

c) Lifting arrangement for the machine.

d) Foundation frame complete with foundation bolts and base frame.

e) Lube oil system integral with the prime mover lube oil system.

f) Spares for commissioning - recommendation

g) List of Spares for 4 years / 1010 hours of operation and maintenance.

h) Any other part / accessories not specifically mentioned above but considered necessary for safe and reliable operation.

1.7 Codes and Standards:

Unless they are in variance with the clause of this specification the diesel engine driven generator and their components shall comply with the latest edition of the applicable standards listed below:

IS: 22534 Designation for type of construction and mounting arrangement of rotating electrical machines.

IS: 46914 Degree of protection providing by enclosures of rotating electrical machinery.

IS: 47284 Terminal marking of rotating electrical machines.

IS: 71324 Guide for testing 3 Ph. sysn. Machines.

IS: 54224 Turbine type generators.

IS: 48894 Methods of determination of efficiency of rotating electrical machines.

IS: 12714 Insulating materials for Electric machinery and apparatus in relation to their thermal stability service, classification of

IS: 47224 Specification for rotating electrical machines.

IS: 25164 A.C. Circuit breakers.

1.8 Performance Requirements:

1.8.1 Operative Conditions:

Generators shall be suitable for operating satisfactorily in humid and corrosive atmosphere found in pump house. Service conditions shall be as specified in the data sheet. The generator shall operate satisfactorily under sudden load application. Generator rating indicated in the data sheet shall be the net output of the set after accounting for all auxiliaries for the prime mover and generator.

1.8.2 Transistant Voltage performance

The dip or rise in system voltage load variations is dependent on the leakage voltage drop of the machine, which shall be kept to the minimum.

In case of sudden application of minimum 60% Block load at rated power factor the voltage drop shall not exceed 15% of the rated voltage. The rated voltage shall be restored within 0.5 to 0.8 second depending on the size of the machine.

1.8.3 Voltage Regulation

The voltage regulation of the machine shall be within +/- 1 % of the nominal voltage under following conditions :

a. Between no load and nominal load with p.f. of 0.8 lag to unity.
b. With the machine cold or warm.
c. At a speed drop of approximately 3% of the nominal speed.

1.8.4 Voltage setting range :

The generator terminal voltage shall be adjustable with a continuously variable potentiometer. The adjustment range shall be +/- 5%.

1.8.5 Harmonic Content

The maximum permissible deviation from the sine wave shall be 5%. The harmonic content of the voltage shall be less than 3% measured between phases off load and up to nominal rating for a power factor of 0.8 lag to unity and with symmetrical distortion free consumers in circuit.

1.8.6 Frequency limits

The Generator shall be suitable for continuous operation at rated load for frequency variation of +/- 3% of rated value in addition the vendor shall furnish the short time under-frequency operating limits.

1.8.7 Overloads:

The generator shall be capable of withstanding without injury the effect of a 10% overload for one hour.

1.8.8 Short Circuit Conditions:

The generator shall be capable of withstanding without damage, a three phase, a line to line, line to earth or two line to earth short circuit for a period of 3 seconds when operating at rated speed and with an excitation corresponding to 5% over voltage at no load.

1.8.9 Excitation support system

Excitation system shall be provided with short circuit support equipment (Series compounding) to maintain three times the rated current for three seconds in case of short circuit to ensure proper fault clearance in outgoing feeders.

1.9 Design and Construction:

The generator design shall meet the requirement specified in data sheet and shall be suitable for the site conditions specified therein.

The generator shall be mounted on a common base frame together with the prime mover unless otherwise agreed. The generator shall be provided with necessary lifting hooks and two earth terminals for connection to main earth grid.

The generator winding shall be class "H" insulation with temperature limitation for class "H" the windings and overhangs shall be braced to withstand the short circuit forces.

The stators windings shall be brought out to suitable terminals in terminal boxes. The terminal box for control cables shall contain properly marked terminals for all internal equipment e.g. embedded temperature detectors etc. All terminals shall be stud type. The terminal boxes shall be complete with lugs and double compression cable glands. Current transformers shall be as specified in data sheet.

All parts and accessories shall be suitable to withstand stress due to over speed / overload / short circuit conditions specified.

Bearings shall be single shielded and relubricated. Grease in the bearing enclosure shall provide additional lubrication to bearing as well as provide sealing against dust and moisture.

The generator shall be air cooled unless otherwise agreed generator enclosure shall be as specified in data sheet.

The direction of rotation of the rotor of the machine shall be compatible with that of the prime mover. A clear indication of the direction of rotation shall be given on either end of the machine.

Space heaters shall be installed within the enclosure, location and max. surface temperature of the heaters shall be such that no damage can be caused to any insulation. Heaters shall suitable for operation on a single-phase 240V AC supply unless otherwise specified.

A suitable double pole switch shall be mounted on or adjacent to the stators frame or enclosure for the manual switching off of the heaters.

Field winding shall have class "H" insulation with excellent electrical and mechanical properties. The field winding shall be capable of operating at a field voltage of 125% of rated load field voltage for at least one minute starting from stabilized temperatures at rated conditions.

All cabling on the generator set skid shall be in GI cable trays/ conduits. All cables shall be identified close to their termination point. Double compression type cable glands shall be used for cable termination.

11.12 A rating plate of corrosion resistant material shall be fixed on the generator frame and shall give the following information:

a) Manufacturer's name.
b) Serial Number, Type and frame reference
c) Rated output in KVA & KW.
d) Rated power factor, frequency and voltage
e) Rated stators current and speed in Rev. / Min.
f) Class of insulation
g) Phase rotation (CW or CCW)

1.10 Excitation System :

The generator shall be provided with brushless type solid state excitation system with automatic voltage regulator. The excitation system shall include the automatic voltage regulator, AC exciter and rotary rectifier. The field of the exciter shall be fed from the stators winding through a suitable transformer and AVR. AC Voltage generated in the AC exciter shall

be rectified by the rotary rectifier assembly and fed to the main field circuits. The rotor windings of the AC exciter, the rectifier assemble, main field winding of the generator and other accessories on rotor part shall be rigidly fastened to the shaft and the connection with different items shall be anti-loosening type.

The exciter capacity shall be at least 20% more than the maximum requirement at any time. The exciter winding shall be insulated with class "H" insulation.

Automatic solid state voltage shall be provided with the following features as a minimum.

- Under frequency protection.
- short circuit protection.
- Cross current compensation for parallel operation.
- Voltage build up circuitry.
- Stators current limited.
- Field current limited.

The Current and potential transformers required to feed the AVR from the generator terminal shall be adequately rated.

1.11 System Operation

The emergency generator set shall normally be in an unattended area. The Control system shall operate in fail safe mode and shall include all controls and protection necessary for the safe operation of the package. The generator set shall function as per one of the following schemes:

– Auto main failure scheme (AMF).
– Manual start in service mode.

1.12 Generator Control Panel :

DG Controller Based and Automatic Mains Failure / Aux. Panels.

1.12.1 Scope

The scope of this section comprised of fabrication, supply, earthing, testing & commissioning of Synchronizing, and AMF/Aux. panels. These panels shall be suitable for operation on 3 Phase 415 volts, 50 cycles. The degree of protection for enclosure shall be IP-52. All panels shall be CPRI approved.

Synchronizing panels and AMF/Aux. panels shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-13947-1993.

1.12.2 Construction Features

Synchronizing and AMF panels shall be 2 mm thick sheet steel cabinet for indoor installation, dead front, floor / wall mounting type and shall be form 3b construction. The Synchronizing / AMF panels shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket and padlocking arrangement. Panels shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of Synchronizing / AMF panels shall be 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to IS-8623-1993 (Part-1) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate

thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of Synchronizing / AMF panels. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels. Minimum clearance of 275 mm shall be provided between the floor of AMF panels and the lowest unit.

Synchronizing / AMF panels shall be of adequate size with a provision of spare switchgear as indicated on the Single Line Diagram. Switches shall be arranged in multi-tier. Knockout holes of appropriate size and number shall be provided in the AMF panels in conformity with the location of cable/conduit connections.

Synchronizing / AMF panels shall be suitable for top cable duct connection for incoming from alternator and bus duct connection for outgoing to LT panel. Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram engraved on PVC sheet. All live accessible connections shall be shrouded and minimum clearance between phase and earth shall be 20 mm and phase to phase shall be 25 mm.

All panels shall have provision of pad locking of breaker handles in OFF position.
Panel must be future expandable type.

1.12.3 Bus Bar Connections

Bus bar and interconnections shall be of high conductivity electrolytic copper and of rectangular cross section suitable for carrying the rated full load current and short circuit current without overheating of phase and neutral bus bars and shall be extendable on either side. Bus bars and interconnections shall be insulated with heat shrinkable sleeve and shall be colour coded. Bus bars shall be supported on glass fiber reinforced thermosetting plastic insulated supports at regular intervals to withstand the force arising from in case of short circuit in the system. All bus bars shall be provided in a separate chamber and all connections shall be done by bolting. Additional cross sectional area to be added to the bus bar to compensate for the holes. All connections between bus bars and breakers shall be through solid strips of proper size to carry full rated current and insulated with insulating sleeves.

1.12.4 Temperature - Rise Limit

Unless otherwise specified, in the case of external surface of enclosures of bus bar chamber and trunking system which shall be accessible but do not need to be touched during normal operation, an increase in the temperature rise limits of 25° C above ambient temperature shall be permissible for metal surface and of 15° C above ambient temperature for insulating surfaces as per IS 8623(Part-2) 1993.

AMF / Synchronizing panels shall be provided with ACB's / MCCB's of appropriate capacity as per Single Line Diagram. AMF / Synchronizing Panels shall be completely factory wired, ready for connection. All the terminals shall be of proper current rating and sized to suit individual feeder requirements. Each circuit shall be clearly numbered from left to right to correspond with wiring diagram. All the switches and circuits shall be distinctly marked with a small description of the service installed.

1.12.5 14.5 Cable Compartments

Cable compartment of adequate size shall be provided in the AMF / Synchronizing panels for easy clamping of all incoming and outgoing cables entering from the top/bottom. Adequate supports shall be provided in cable compartment to support cables.

1.12.6 Air Circuit Breakers (ACB)

A. The ACB shall conform to the requirements of IEC 60947-2 / IS 13947. The circuit breaker shall be suitable for 415 + 10% 50 Hz supply system. Air Circuit Breakers shall be moulded housing, draw out type and shall be provided with a trip free manual operating

mechanism or as indicated in drawings and bill of quantities with mechanical "ON" "OFF" "TRIP" indications.

The ACB shall be 3/4 pole with modular construction, draw out, manually or electrically operated version as specified and shall be capable of providing short circuit, overload and earth fault protection through micro processor based control unit sensing the true RMS valve to ensure accurate measurement meeting the EMI/EMC requirement as per standard.

The circuit breakers shall be for continuous rating and service short Circuit Breaking capacity shall be as specified on the single line diagram and shall be equal to the short circuit withstand values.

Circuit breakers shall be designed to `close' and `trip' without opening the circuit breaker compartment door. The operating handle and the mechanical trip push button shall be at the front of the breakers panel and integral with the breaker.

The ACB shall be provided with a door interlock. The contacts shall be of silver plated copper with a feature of contact wear inspection, indicating the life of the contacts. The ACB shall have double insulation (Class-II) with moving and fixed contacts totally enclosed for enhanced safety and in accessibility to live parts. All electrical closing breaker shall be with electrical motor wound stored energy spring closing mechanism with mechanical indicator to provide ON/OFF status to the ACB.

B. Cradle

The cradle shall be so designed and constructed as to permit smooth withdrawal and insertion of the breaker into it. The movements shall be free from jerks, easy to operate and shall be on steel balls/rollers and not on flat surfaces.

There shall be 4 distinct and separate position of the circuit breaker on the cradle.

Service Position : Main Isolating contacts and control contacts of the breaker are engaged.

Test Position : Main Isolating contacts are isolated but control contacts are still engaged.

Isolated Position : Both main isolating and control contacts are isolated.

Maintenance :Circuit breaker fully outside the panel ready for maintenance after the cubicle door is opened.

There shall be provision for locking the breaker in any or all of the first three positions.

C. Safety Features

i. The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.

ii. It shall not be possible to interchange two circuit breakers of two different thermal ratings.

iii. There shall be provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism. Earthing bolts shall be provided on the cradle or body of fixed ACB.

iv. Arc Chute covers wherever necessary shall be provided.

v. The AMF panel accommodating ACB shall be provided with indicating lamps for ON-OFF positions, electronic type meter of accuracy class 1..0 with suitable ratio CT's to measure and display various electrical quantities as mentioned in Schedule of Quantities with built-in selector switches, MCB for protection circuit and current transformers.

vi. It shall be possible to bolt the draw out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.

1.12.7 Moulded Case Circuit Breaker (MCCB)

MCCB shall be Current Limiting and comprise of Quick Make - break switching mechanism, preferably Double Break Contact system, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses. All MCCB's shall be capable of defined Variable overload adjustment. All MCCB's upto 250 Amps shall have thermal magnetic releases and above 250 amps shall have microprocessor based release with adjustable magnetic short circuit pickup. Wherever MCCB with earth fault protection mentioned in BOQ, the protection shall be an integral part of the release with adjustable magnetic short circuit and earth fault protection with time delay.

The trip command shall override all other commands. MCCB shall employ maintenance free double break contact system to minimize the let thru' energies and capable of achieving discrimination upto full short circuit capacity of downstream MCCB. The manufacturer shall provide both discrimination tables and let thru energy curves.

The breaking capacity of MCCB's shall be as asked for in the schedule of quantities. The breaking capacities specified shall be ICU=ICS i.e type-2. Co-ordination as per IEC-60947-2, 1989/IS 13947-2, 1993.

The MCCB's shall be provided with rotary handle operating mechanism. The handle position shall give positive indication of 'ON', 'OFF' or 'Tripped' thus qualifying to Disconnection as per the IS/IEC indicating the true position of all the contacts. In case of 4 pole MCCB the neutral shall be defined and capable of offering protection.

1.12.8 Miniature Circuit Breaker (MCB)

Miniature Circuit Breaker shall comply with IS-8828-1996/IEC898-1995. Miniature circuit breakers shall be quick make and break type for 240/415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCBs shall be classified (B,C,D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values.

The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP, TPN and 4 Pole miniature circuit breakers shall have a common trip bar independent to the external operating handle.

1.12.9 Earthing

Earthing shall be provided as per IS:3043-1987.

1.12.10 Painting

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivating (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/outside shall be RAL-7032 of IS Code No.5.

1.12.11 Labels

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the distribution panels shall be pasted on inside of the panel door and covered with transparent plastic sheet.

1.12.12 Meters

i. All voltmeters and indicating lamps shall be through MCB's.
ii. Meters and indicating instruments shall be digital electronic type.
iii. All CT's connection for meters shall be through Test Terminal Block (TTB).
iv. CT ratio and burdens shall be as specified on the Single line diagram.

1.12.13 Current Transformers

Current transformers shall be provided for Synchronizing / AMF / AUX panels. All phase shall be provided with current transformers of suitable VA burden with 5 amps secondaries for operation of associated metering.

The CTs shall confirm to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast/ Flame Retardent resin filled Nylon type robust to withstand thermal and dynamic stresses during short circuits. Metering CTs, shall have inbuilt busbar mounting arrangement. Secondary terminals of CTs shall be brought out suitable to a terminal block which shall be easily accessible for testing and terminal connections. The secondary terminal should be covered with insulation cap/cover so that there should not be any possibility of touching the live terminal. The protection CTs shall be of accuracy class 5P10 and measurement CTs shall be of accuracy class I.

1.12.14 Selector Switch

Where called for selector switches of rated capacity shall be provided in control panels, to give the choice of operating equipment in selective mode.

1.12.15 Contactor

Contactor shall be built into a high strength thermoplastic body and shall be provided with an are shield for quick are extinguishing. Silver alloy tips shall be provided to ensure a high degree of reliability and endurance under continuous operation. The magnet system shall consist of laminated yoke and armature to ensure clean operation without hum or chatter.

Starters contactors shall have 3 main and 2 Nos. NO / NC auxiliary contacts and shall be air break type suitable for making and breaking contact at minimum power factor of 0.35. For design consideration of contactors the starting current of connected motor shall be assumed to be 6 times the full load current of the motor in case of direct-on-line starters and 3 times the full load current of the motor in case of Star Delta Starters. The insulation for contactor coils shall be of Class "E".

Coil shall be tape wound vacuum impregnated and shall be housed in a thermostatic bobbin, suitable for tropical conditions and shall withstand voltage fluctuations. Coil shall be suitable for 240 / 415 + 10% volts, 50 cycles AC supply.

1.12.16 Thermal Overload Relay

Thermal overload relay shall have built in phase failure sensitive tripping mechanism to prevent against single phasing. The relay shall operate on the differential system of protection to safeguard against three phase overload, single phasing and unbalanced voltage conditions.

Auto-manual conversion facility shall be provided to convert from auto-reset mode to manual reset mode and vice-versa at site. Ambient temperature compensation shall be provided for variation in ambient temperature from –5deg C + 55 deg C.

All overload relays shall be of three element, positive acting ambient temperature compensated time logged thermal over load relays with adjustable setting. Relays shall be directly connected for motors upto 35 HP capacity. C.T. operated relays shall be provided for motors above 35 HP capacity.

1.12.17 Time Delay Relays

Time delay relays shall be adjustable type with time delay adjustment from 0-180 seconds and shall have one set of auxiliary contacts for indicating lamp connection.

1.12.18 Toggle Switch

Toggle switches, where called for in Schedule of Quantities, shall be in conformity with relevant IS codes an shall be of 5 amps rating.

1.12.19 Push Button Stations

Push button shall be provided for manual starting and stopping of motors / equipment "Green" and "Red" colour push buttons shall be provided for 'Starting' and 'Stopping' operations. 'Start' or 'Stop' indicating flaps shall be provided for push buttons. Push buttons shall be suitable for panel mounting and accessible from front without opening door, Lock lever shall be provided for 'Stop' push buttons. The push button contacts shall be suitable for 6 amps current capacity.

1.12.20 Indicating Panel

All meters and indicating instruments shall be in accordance with relevant Indian Standards. The meters shall be flush mounted type. Indicating lamps shall be of low burden, and shall be backed up with 2 amps MCB.

1.12.21 Testing

Testing of panels shall be as per following codes:

IS: 8623 (Part -I) 1993 for factory built assemblies of switch gear for voltages upto and including 1010 VAC.
IS: 13947 : 1993 Degree of protection
IS: 5578 & 11353:1985 Arrangement of bus bars.

1.12.22 Anti-Condensation Space Heaters

1 No. 100 W, 240 Volts single phase, 50 Hz AC Anti Condensation space heaters controlled by thermostat and protected by 6 amps MCB's or MPCB's as per fault level at the panel shall be provided in each vertical section of AMP / Synchronizing panel and 1 No. 60 watt Anti Condensation space heater shall be provided in each cable alley of DG Auxiliaries panel and sub distribution boards. Supply and control equipment for the above shall be provided by the vendors.

1.12.23 DG Controller Function

A. General

The auto synchronizing cum LT panel shall have DG controller with following general requirements for AMF start, Auto synchronizing and Auto Load sharing functions.

B. AMF function

In the case of failure of normal power supply of individual substations

1. Generator to start after a prefixed time of three second on any of the following conditions :

   a. Total absence of voltage.
   b. Failure of one or two phases.
   c. Under voltage below 375 volts.
   d. Overvoltage of more than 6%.

2. After a lapse of 10-12 seconds normal power supply breaker to open and Generator supply breaker to close.

   In the case of Resumption of Normal Power supply :

3. Generator breaker to open and normal power supply breaker to close after three seconds on resumption of normal power on the following conditions.

   a. All the three phases available at the normal supply breaker.
   b. 380-415 volts available at the normal supply breaker.

4. Generator to over run for the three minutes and stop automatically.

5. All auxiliaries to stop automatically.

6. Generator to be ready for the next operation automatically.

C. Summary Of Functions

The following functions shall be performed by the controller for Synchronizing the generating sets.

Automatic starting of generating sets.

Automatic Synchronization of all available generating sets.

Automatic load sharing between generators, active as well as reactive load sharing.

Starting & stopping of generators as per load requirement.

Monitoring of engine & alternator condition and protections.

Complete load management as per requirement.

The control functions shall be as follows :

Engine Control

Speed monitoring
Over-speed protection
Oil pressure monitoring
Water temperature monitoring
Battery voltage monitoring.

Engine Protective Features

High / Low coolant temperature

High / Low oil pressure
Over-speed
Start Failure

Generator Protective Features

Over / Under voltage.
Over / Under Frequency
Reverse Power (Inverse time delay)
Loss of Excitation
Over Current (Inverse time delay)
Current Unbalance
Voltage Unbalance

Reactive (KVAR) Control
VAR sharing on isolated busses using %age base reactive load sharing.
Power factor or VAR control when base loaded
Externally adjustable VAR of PF set point levels.

Control System

All the electrical parameters are monitored centrally through DG controller. All the electrical data is brought to the DG controller & then DG controller controls the complete Synchronizing, Load Control & Management system.
No motorized potentioners are used. AVR & Governor are given direct bias control (Analog / Plum Commands).

1.12.24 Protection Through Relays
(Applicable for both synchronizing and AMF panel)

Following protection shall be provided through relay both for the stator side and the rotor side:

Restricted Earth fault Relay : Relay shall have REF protection element (64R), which shall monitor the generator for internal earth faults. It has a built-in O/C protection, as a back up.

Over voltage and under voltage protection.

In addition to above, following relays to be provided

Master Trip Relay
Trip Circuit Supervision Relay
Engine Cranking Relay

1.12.25 Metering for Each Generator

As mentioned in the Schedule of Quantities.

1.12.26 Annunciation

Annunciation with Hooter, Test, Accept and Reset P.B. and Annunciator.

14 Window Solid State Annunciator for each DG sets.

Channel No.	Inscription
01	Set fails to start (only alarm)
02	Over current (breaker trip)
03	Earth Fault (Breaker trip)
04	Excitation Failure (Engine should be stop with breaker trip)

05	Reverse Power (Breaker trip)
06	Emergency Shutdown (Breaker will trip with engine stop command)
07	Over speed (Breaker will trip with engine stop command)
08	Low Lube Oil pressure (Breaker will trip with engine stop command)
09	High Water Temperature (Breaker will trip with engine stop command
10	Under Voltage (Breaker trip)
11.	Over Voltage (Breaker trip)
12	Bearing Temperature high (breaker will trip with engine stop command)
13.	Under Frequency (Breaker trip)
14	Over Frequency (Breaker trip)
15.	Winding Temperature High Breaker with trip with engine stop command)
16.	Low fuel oil level (only alarm at preset level.

1.12.27 The Local generator control panel for the generator set shall comprise of the following unless otherwise specified in the attached data sheet & Technical specification in 17.

(a) Protection and metering equipment's.

(b) Indicating instruments.

(c) Control gear for generator set auxiliaries.

Any other accessory require to make the generator set operational as a package shall be included in scope of supply . If required the generator control panel shall be split into various functional sections vi. protection, metering and control, regulation etc.

All motor starters for generator set auxiliaries shall be DOL type.

1.13 Painting, Packing and Transport:

All metal surfaces shall be thoroughly cleaned of scale, rust and grease etc. prior to painting. Cleaned surfaces shall be given two coats of primer and prepared for final painting. Final finish shall be free from all sorts of blemishes.

The equipment shall be shipped to site suitably packed to prevent any damage. Each package shall have labels to show purchaser's name, purchase order and equipment no. suitable lifting lugs etc. shall be provided and lifting points shall be clearly marked on the package. Packing shall be suitable for storage at site for a minimum period of 6 months.

1.14 Tests and Inspection :

The owner or his authorized representative may visit the works during manufacture of equipment to assess the progress of work as well as to ascertain that only quality raw materials are used for the same. He shall be given all assistance to carry out the inspection.

Detailed test procedure along with the facilities available at vendors works shall be furnished along with the bid Owner's representative shall be given minimum four weeks advance notice for witnessing the final testing. Test certificates including test records and performances curves etc. shall be furnished by the vendor.

1.14.1 Tests

Equipment shall be tested to confirm to the appropriate standards and the following tests shall be conducted in the presence of purchaser's:

Functional tests, continuity tests and high voltage test on control panel to establish the performance called for in the specification.

- Power frequency voltage test on switch gear and mechanical / electrical operational check.
- Routine tests for alternator as per IS: 4722.
- Over speed test (to be provided by way of engine test certificate)
- Transient response tests for sudden application and rejection of loads of 0 to 60 %
- Wave form test (type test results are acceptable)
- Phase sequence test.
- Vibration test
- Noise level test.
- Dimensional and alignment test.
- Test certificate of engine / alternator / breaker manufacturer is acceptable

1.15 Technical Specifications of Diesel Engine Generator Sets rating

Diesel Engine

The diesel engine shall be of the 4 stroke cycle, prime rated continuous, multi-cylinder direct injection, compression ignition type operating at a speed of 1500 rpm and shall be silent, vibration free while in operation and comply Center / State Pollution Control Board and shall conform to BS:649/5514.

The engine shall be complete with radiator cooled type engine, fan, lubricating oil pump, lubrication oil pressure gauge (or microprocess built-in display), tachometer, digital integrated hours-run recorder, over-speed trip and all other necessary auxiliaries.

The brake horse power of the engine with all attached accessories as specified shall not be less than that which is required by the full load rating of the alternator at site operating conditions taking into consideration losses, plus a reserve factor of at least 10%.

Standard Equipment:

Radiator with blower fan & Fan Guard.
Corrosion inhibitor coolant
Paper element filters – fuel, lubricating oil and by-pass
Flywheel to suit single/double bearing alternator & Flexble Coupling with starter ring.
Flywheel housing
Dry type air cleaner with vacuum indicator
Residential Silencer
Stainless steel exhaust flexible bellow
Electric Starter
24V Electric starting system
Battery charging alternator
Safety Controls (trip) : High water temperature (HWT)
Low lubricating oil pressure (LLOP)
Engine overspeed
Exhaust Gas Turbocharger with after cooler
Bypass thermostat

Brief Technical Particulars : (To be Given By Bidder)

Nos. of cylinders
Bore x Stroke (mm)
Compression Ratio
- Voltage
- Voltage regulation
- Voltage adjustment

Coolant capacity (engine only)
Specific fuel consumption at rated load
(As per ISO: 3046/BS 5514)

Rated Output(Prime Rating)

The above fuel consumption datas are based on engine operating with diesel fuel corresponding to Grade no. 2D as per ASTM D975/IS 1460:1995

This engine should be meets latest CPCB emission norms

Exhaust System

Adequate sized piping and fittings shall be installed to carry the engine exhaust discharge into the atmosphere at a height as indicated in the drawings & as per the requirement of Center / State Pollution Control Board or Pollution Control Committee as the case may be.

M.S. epoxy painted structural support and vibration arrestors for D.G. set chimney to specify along with drawing for statutory clearance..

Mufflers shall be installed to reduce the engine exhaust noise at the outlet of muffler to noise level as permitted at site as per CPCB requirements. Flexible connection shall be provided between the engine and the fixed piping.

Engine instrument panel

An instrument panel mounted on the engine shall be provided and shall comprise the following flush-mounted instruments and gauges:

- Lubricating oil pressure gauge
- Tachometer, positive driven
- Hour counter with hour totalizer.
- Protection Devices
- Warning indication and automatic shut-down shall be provided for the following:
- Low oil pressure shutdown and alarm
- high coolant temperature alarm
- High coolant temperature shutdown
- Fail to crank shutdown
- Overcranking shutdown
- Overspeed shutdown
- Low & high DC voltage alarm
- Low battery alarm
- Low fuel-day tank alarm
- High and Low AC voltage shutdown
- Under frequency shutdown
- Over current and alarm and shutdown
- Short circuit shutdown
- Earth fault alarm
- Overload alarm
- Emergency stop

Failure indication lights and alarm for all fault conditions shall be provided on control panel for restoring the operation to normal.

The starting circuit shall be disconnected in the event of any of the above shutdowns.

1.16 Vibration Control

The complete generator assembly shall be isolated on static deflection unhoused spring-neoprene in series isolator with non-skid neoprene pads. Start-up and shut down rocking restraint snuffers shall be provided at four corners of base frame.

All fuel line pipes shall be cushioned with a layer of harnesss and neoprene pad at attached points.

All pipe work and engine silencers shall be suspended on static deflection spring-neoprene in-series hangers.

Detail calculation and proposal for justifying the size and provision shall be provided for Project Manager review prior to the installation.

Emission standards for Diesel Engines (Engine rating more than 800 KW) for generating sets

Parameter		**Area Category**	**Total engine rating of the plant (includes existing as well as new generator sets)**	**Generator sets commissioning date**
				On or after 1.7.2005
NOx (as NO2) (at 15% O2), dry basis, in ppmv		A	Upto 75 MW	710
		B	Upto 150 MW	
NMHC (as C) (at 15% O2), mgNm3		Both A and B		100
PM (at 15% O2), mgNm3	Diesel Fuels HSD & LDO	Both A and B		75
	Furnace Oils – LSHS & FO	Both A and B		100
CO (at 15% O2), mgNm3		Both A and B		150
Sulphur Content in fuel		A		<2%
		B		<4%
Fuel specification		For A only	Upto 5 MW	Only diesel fuels (HSD, LDO) shall be used.
Stack height (for generator sets commissioned after 1.7.2003)		Stack height shall be maximum of the following in meter : 14 Q0.3, Q=Total SO2 emission from the plant in Kg / hr Minimum 6 m above the building where generator in installed. 30 m.		

Acronyms Used

MW	:	Mega (106) Watt
NOx	:	Oxides of Nitrogen
NO2	:	Nitrogen Dioxide
O2	:	Oxygen
NMHC	:	Non-Methane Hydrocarbon
C	:	Carbon
PM	:	Particulate Matter
CO	:	Carbon Monoxide
SO2	:	Sulphur Dioxide
ppmv	:	Part per million (106) by volume
FO	:	Furnace Oil
HSD	:	High speed diesel
LDO	:	Light Diesel Oil
LSHS	:	Low Sulphur Heavy Stock
kPa	:	Kilo Pascal
mm	:	Milli (103) meter
kg/hr	:	Kilo (103) gram per hour
mg / Nm3	:	Milli (103) gram per Normal metre cubic

Area Categories A & B are defined as follows:

Category A : Areas within the municipal limits of towns / cities having population more than 10 lakhs and also upto 5 km beyond the municipal limits of such towns / cities.

Category B : Areas not covered by Category A

The standards shall be regulated by the State Pollution Control Boards or Pollution Control Committees, as the case may be.

LIMITS OF NOISE FOR POWER GENERATING SETS (UPTO 1010 KVA) MANUFACTURED ON OR AFTER THE 1ST JULY, 2003

Applicability

These rules apply to Generator sets upto 1010 KVA rated output, installed on or after 1st July, 2003.

Requirement of Certification

Every manufacturer or importer of Power Generating set must have valid certificates of Type Approval and also valid certificates of conformity of production for each year, for all the product models being manufactured or imported after 1st July, 2003 with the specified noise limit.

All Power Generators shall have a valid Type Approval certificate and conformity of production certificate.

All Power Generator shall have conformance label meeting the requirements.

The conformance label shall contain the following information :

Name and address of the supplier (if the address is described in the Owner's manual, it may not be included in the label).

Statement "This product conforms to the Environment (Protection) Rules, 1986"

Noise limit viz. 75 dB(A) at 1 meter under free field condition

Type approval certificate number.(for less than 1010 kva DG set)

Date of manufacturer of the product. (for less than 1010 kva DG set)

Authorized agencies for certification

The following agencies are authorized to carry out such tests as they deem necessary for giving certificates for Type Approval and Conformity of production testing of Generator and to give such certificates :

Automotive Research Association of India, Pune.

National Physical Laboratory, New Delhi.

Naval Science & Technology Laboratory, Palghat

National Acrospace Laboratory, Bangalore

Alternator:

The above diesel engine will be coupled with the brushless type Alternator of 500 KVA / 560 KW. The make of Alternator shall be as specified. The alternator shall be with salient features like self excited, self regulated through AVR, three phase, 415 Volts, 50 Hz, 1500 RPM, screen protected, drip proof. The alternator shall generally confirm to IS: 4722/BS: 2613 standards. The alternators shall be with class H insulation & temperature rise limited to class "H". The alternator shall be suitable for 45°C Ambient Temperature. The alternator shall be single bearing type.
The alternator shall be generally confirming to IS: 4722/BS: 5000 standards & shall be suitable for 10%overload for 1 hours in continuous 12 hours duration.

Automatic Voltage Regulator

a. An automatic high speed, dead band type voltage regulator shall be provided, complete with all accessories. The regulation system shall be provided with equipment for automatic and manual control.

b. The regulator shall regulate the output voltage from generator current and potential signals. Series compounding transformer shall be provided to enable maintaining adequate terminal voltage in the event of terminal faults. Alternatively excitation system shall be provided with arrangement for field forcing. Contractor shall coordinate suitability of protection relays for generator with the operational characteristics of automatic voltage regulator, specially under short circuit conditions.

c. Voltage regulation and steady state modulation shall be within + 1% of the line voltage.

d. Necessary equipment for field suppression and surge protection shall be provided.

e. The response time of exciter and the generator shall be properly matched to avoid hunting.

f. AVR system shall be provided with equipment for automatic and remote operation / control.

g. Necessary equipment shall be furnished for the following.

To prevent automatic rise of field voltage in case of failure of potential supply.
To initiate transfer from automatic to manual control of excitation on fuse failure on the generator potential signal.

AMF control panel for 500 KVA :

The Control panel shall be fabricated out of 14 SWG M. S. sheet. The panel shall be suitable for floor mounting, indoor type, cubicle design, dust & vermin proof. The panel shall be painted with paint shade Siemens Grey. The sheet steel shall be treated for degreasing, rinsing, degreasing, pickling, phosphating & passivation through 7-tank process.

Microprocessor based Engine generator Control package with built in AMF with Protection like Over Current, Reverse Power, Under/Over Voltage, Under / Over Frequency, etc.. with inbuilt key features as under:

8 Relay Outputs, 8 Static Outputs & 3 Programmable Digital Inputs
3 Programmable Static Outputs, configurable to one of over 10 function types
13 Digital Inputs, 1 Pick Up Input for RPM monitoring
D+/W.L. control & 3 Channel Analogue Sender Interface
3-phase Generator & Mains Voltage Monitoring upto 500 V ac
External Adaptor to monitor upto 1010 V ac-3-phase
3-phase Generator Current monitoring upto 9900 A

Digital Metering for Amp. Voltage, Frequency,Power Factor, KW, KVA, KVAR, KWH, EngineRun Hour, Battery Voltage etc…
Announciation for Various Faults.
Serial Interface RS 232 or RS 485 for Grid Parrareling, Import / Export Facility, remote control & monitoring
Aac, Vac, Hz, Vdc, kVA, kW, kVAr & PF monitoring
Oil pressure, Engine Temperature & Fuel Level measurements
Manual, Automatic, Remote & Off operating modes
Event & Data Logging Memory & Hour Counter
Automatic Scheduled Testing & Service/Maintenance
6 Point Relationship for analogue senders upto 1010 Ohm
Cycle Lube Interval, Automatic Transfer Fuel Pump Control
Extended Temperature Range/Humidity -30°C to +70°C/95% HR

Incomer / Outgoing

Incomer : 1 no. FP type, 800 Amps. 36 KA MCCB of specified make – Adjustable Microprocessor based release for overcurrent, short circuit & earth fault release complete with 3 CT's of Class 1, 15 VA, 800/5 Amp. With following accessories.

1 no. digital type Ampere meter with inbuilt selector switch
1 no. digital type Voltmeter with inbuilt selector switch
1 no. digital type KW/PF meter
1 no. digital type Frequency meter
1 no. 3 phase, 4 wire, Panel mounted Digital Type KWH meter
Necessary set of instrument fuses, HRC type
3 nos. 800/5 Amps ratio current transformers for metering, class 1.0, 15 VA burden
3 nos. 800/5 Amps ratio current transformers for relay, class 1.0, 15 VA burden
1 no. F-Thyrsitor (Primary) Controlled Constant Voltage Constant Current Automatic Battery Charger
1 no. 96 sq.mm Analogue type DC Ampere meter
1 no. 96 sq.mm Analogue type DC Voltmeter
2 set (12 nos.) of indicating lamps, LED type
Load on Genset
Load on Mains
Mains R, Y, B
Genset R, Y, B
1 no. 4-point annunciator with inbuilt hooter, Test, Accept & Reset push buttons for the following,
Low lubricating oil pressure
High water temperature
Engine overspeed
Relay operated
Auto/Manual Selector Switch for MCCB ON/OFF
1 no. TNC type Breaker Control Switch for Genset MCCB / DG

Base Frame:

Suitable and recommended base frame of sturdy design made out of M. S. channel with necessary reinforcement & pri-drilled holes. The base frame shall be made out of reputed steel company. The diesel engine and alternator will be coupled on this base frame. skid mounted type providing common bed for engine and alternator. Provision is made in Base Frame for lifting arrangement of DG set.

Discription mentioned in above panel is indicative supplier has to provide all components as per specifications.

Acoustic Enclosure:

The Generating sets should be housed inside a high quality acoustic enclosure having salient features & constructional features such as:

Compact, modular construction & sleek design with low noise level 75dBA @ 1 mtr distance in free field condition.

Soundproof, weatherproof & environment-friendly silent set with top lifting facility, preffered 6 sided enclosure Ready-to-use silent set, eliminates need for foundation or grouting.

The acoustic enclosure is manufactured & powder coated & lined with Fireproof Acoustic Material light resin rock wool as per IS: 8518. The material shall be of 48-kg/m3 density & the layer shall be 75-mm thick.

It is made of compact sleek design confirming to international standards to provide insertion loss of 25 dBA meeting CPCB norms. (1.6 / 2 mm thick CRCA sheet)
Steel outer construction with heavy-duty fabricated base frame & inbuilt fuel tank.
Attenuators are placed in the hot air outlet & cooling air inlet.
Exhaust silencer – Residential type mounted on the enclosure, exhausting to atmosphere.
All joints are sealed with fireproof neoprene gaskets, which withstand high temperature & pressure.
All high temperature exposed surfaces are insulated by glasswool with aluminium cladding.
Painted with weatherproof, acidproof, heat-resistant, powder-coated after pretreatment for degreasing, derusting, pickling, phosphating & passivation for durability & better look.

Fuel Tank :

Silent Gensets have a unique "Built in fuel tank" which provides absolute safety and protection from any mishap unlike conventional systems.

The daily fuel tank should be suitably designed so as to provide long hours of uninterrupted and continuous power. For ease of monitoring the fuel level in the fuel tank, a sophisticated fuel level gauge should be provided in the control panel. For ease of operation, there is a provision for fuel inlet, which has accessibility from outside the acoustic enclosure, and designed so that the refueling is possible even when the generating set is in operation. The tank should be fabricated from M.S. Sheet, duly painted and fitted with inlet-outlet connections, air-vent, drain valve & level indicatiors suitable for 8 Hrs running.

Batteries :

2 nos. of Batteries will be required with each Genset. Each battery shall be of 12 Volts and of EXIDE / EQUIVALENT make with leads & Battery Cable.

Vendor to submit battery calculation.

BATTERY CHARGER

General

The battery charger shall be SMPS type. The charger shall have selector switch for Auto Float – Boost / Manual Float / Manual Boost Mode of operation. During Auto Float – Boost Mode, Automatic Changeover shall take place from Float Mode to Boost mode and Vice-Versa. This means that when the Batteries are fully charged the charging shall automatically change from Boost charge to trickle charge.

Construction Feature

The battery charger shall be housed in sheet steel cubicle of Angle Iron frame work with sheet steel panels of 1.6 mm thickness. Louvers shall be provided in the cabinet for the ventilation. The cubicle shall be painted in Siemens Grey shade RAL7032 of IS-5. Four wheels shall be provided at the base.

Performance

The D.C output voltage of Float / Boost charger shall be stabilized within + 2% for AC input variation of 230 V + 10%, frequency variation of 50 Hz + 5% and DC load variation of 0-100%. The voltage regulation shall be achieved by a constant voltage regulator having fast response SCR control. The ripple content will be within 3% of DC output nominal voltage.

There shall be provision to select Auto Float / Manual Float / Manual Boost modes. During Auto Float Mode the battery charging shall automatically changeover from Boost Mode to Float Mode and Vice Versa. During Manual Float / Boost modes it shall be possible to set the output volts by separate potentiometers.

The battery charger shall have automatic output current limiting feature.

Rating

AC Input	:	230 V + 10% AC 50 Hz single phase.
DC Output	:	To float / boost charge 180 AH batteries and also supply a continuous load.
Current Rating	:	30.0 Amps
Float Mode	:	27.0 V nominal (Adjustable) between 24-28.0 V.
Boost Mode	:	29.0 V nominal (Adjustable) between 24-32.0 V.
Voltage Regulation	:	+ 2% for AC input variation of 230 V + 10%. Frequency Variation of 50 Hz + 5% and DC load variation 0-100%

PRIME MOVER FOR D.G. SET

DATA SHEET

1	Prime mover	:	Diesel Engine
2	Qty required	:	One No. for each alternator.
3	Service	:	Prime mover for generating set.
4	Horsepower	:	As specified in BOQ
5	RPM	:	1500 RPM
6	Type	:	Water cooled
7	Flywheel	:	Require
8	Vibration damper	:	Require
9	Fuel pump air cleaner	:	Require
10	Fuel pump	:	Require
11	Radiator	:	Require
12	Oil filter, fuel Filter etc.	:	Require
13	Lub oil pump	:	Require
14	24 DC V electrical System	:	Require
15	Safety controls	:	1.LLOP, 2.HWT, 3. OS. 4. Cooldown timer 5. Low cool out level.
16	Silencer	:	Required – Residencial Type

17	Coupling	:	Require
18	Instrument panel consist of As specified in Panel.	:	
a)	Meter	:	1.Voltage, 2.Current, 3 frequency, 4.Engine hours.
19	Fuel tank	:	suitable for 8Hrs Running
20	Battery charger	:	Require
20A	Battery charging Alternator 24V DC, 35 Amp.	:	Battery charging Alternator 24V DC, 35 Amp.
21	Engine testing	:	
a)	At shop	:	Require
b)	At site	:	Require
22	Tool kits	:	list of tools req. to be maintain at site.
23	Engine Design temp	:	Require
24	Literature	:	Require
a)	Operation & maintenance manual Parts catalogue/list		

Note:

1. The engine HP. should be selected so as to achieve required KW rating to be generated considering darating of engine due to altitude, temp. @ 45 deg. C, humidity etc.

2. D.G. set should be able to start by AMF panel.

3. The engine test shall be witnessed by the client's representative if required.

ALTERNATOR

DATA SHEET A

1	Make	:	As per Make list
2	Rating	:	As per schedule of quantities.
3	Power factor	:	0.8
4	Rated voltage	:	415 V
5	Voltage regulation	:	5%
6	Rated current	:	As per SOQ
7	Speed	:	1500 RPM.
8	Frequency	:	50 Hz.
9	Method of excitation and Regulation	:	Self
10	Class of insulation	:	A) Stator - H with temp.rise of H
		:	B) Rotor - H --- do ------
11	Degree of protection	:	Screen protected, drip proof.
12	Base plate	:	The Engine & alternator shall be mounted and aligned on a Common base plate fabricated from steel.
13	AMF Panel	:	As per specification
14	PMG exitation / Auxiliary winding	:	Required.

DATA SHEET B (To be furnished by the bidder)

Sr. No.	Description		
A	**ENGINE**	:	
1	Make		
2	Model	:	
3	No. of cylinders	:	
4	Arrangement of cylinders:	:	
5	No. of stroke	:	
6	Speed RPM	:	
7	B.H.P Standard rating	:	
8	S.H.P. Standard rating	:	
9	Max. BHP at site (Overload)	:	
10	Engine overload operations hrs.	:	
11	Recommended fuel oil	:	
12	Compression ratio	:	
13	Firing order	:	
14	Sp. fuel oil consumption (LTR / HR) 0.85 spec. gravity.	:	
15	Recommended Lub-oil	:	
16	Method of starting	:	
	a) Battery details	:	
	b) Charger details	:	
	c) Make of battery & charger.	:	
17	Silencer type	:	
18	Cooling system	:	
19	Fuel system	:	
	1. Filters	:	
	a) Type	:	
	b) Nos.	:	
	2. Injection pump	:	
	a) Type	:	
	b) Nos.	:	
	3. Injector	:	
	a) Type	:	
	b) Cooling	:	
	4. Day tank	:	
	a) Capacity	:	
	b) Location	:	
20	Lubricating system	:	
	1. Type	:	
	2. Filters	:	
	a) Type	:	
	b) Nos	:	
	3. Lub oil pump	:	
	a) Type	:	
	b) Rating	:	
21	Governing system	:	
22	Instrument panel	:	
23	Safety control	:	
24	Max. period for which engine can operate without raw cooling water	:	

Sr. No.	Description		
	supply.		
25	Other accessories	:	
26	Exhaust system	:	
27	Literature	:	
28	Diesel engine auxiliary (Materials of Construction)	:	
	1. Base plate	:	
	2. Fuel oil tank	:	
Note: All data to be supplied by the contractor			

2.0 LT SWITCHGEAR PANEL

A. LT PANEL

2.1 SCOPE:

This specification covers the technical requirements of design, manufacture, testing at manufacturer's works, supply, installation, testing and commissioning of LT Switchgear Panel assembly.

2.2 STANDARDS & CODES:

The equipment covered under this specification shall conform to the latest revisions of relevant Indian and International Standards some of which are listed below:

IS/IEC 61439	Low voltage switchgear and control Gear assemblies
IS /IEC 60947	General requirements of Switchgear and Control Gear for Voltage not exceeding 1000 / 1200V AC
IS 2705 1992	Current transformers
IS 694 1990	PVC insulated cables for voltages including 1100 V with Copper and Aluminum Conductor).
IS 5082	Electrolytic Aluminum Busbar, Trunking system, Rod tubes & sections for Electrical Purposes
IS 13779 1999	AC Electric Meters / Static Meters.
IEC 60529	Degree of Protection

2.3 Technical Parameters:

A.	System Details		
i)	System Voltage	:	415V +/- 10% 3 phase 4 wire solidly grounded network
ii)	Frequency	:	50Hz +/- 3%
iii)	Control Supply	:	415/230 Volts AC +/- 10% (tapped from phase & neutral)
B.	Air Circuit Breakers		
1	Standard Applicable (Isolation function with the test for line/ load inter-changeability)	:	IS: 60947
2	Rate insulation voltage (Ui)	:	1000 Volts
3	One minute dry withstand test voltage	:	2500 Volts
4	Service (Ics) Breaking capacity at 415V, 50Hz	:	As per BOQ
5	Making capacity	:	As per BOQ
6	Momentary short time current	:	As per BOQ

	rating (rms) for 1 sec. (Icw)		
7	Rating of circuit breaker	:	As per bill of material
8	Type of protection relay/release	:	as specified in BOQ
9	Type of tripping mechanism	:	Shunt trip (Electrical)/ Low Power release as specified in BOQ
10	Normal voltage of tripping coils	:	415/ 230 V AC +10% - 15% or as specified in BOQ
11	Voltage for spring charging motor (for stored energy mechanism)	:	230 V AC +10% - 15%
12	ACB Breaker operations	:	Electrically operated with draw out type or as specified in BOQ
13	Electrical Closing and tripping switch	:	By spring return sequence locking type ODS switch
14	Features of circuit breaker	:	Trip free and anti-pumping
15	Method of closing	:	Electrically operated spring charged (normal), mechanical (emergency).
16	Communication capability	:	All ACBs shall have RS 232/ RS 485 port
C	MCCBs		
1	Standard Applicable (Isolation function with the test for line/ load inter-changeability)	:	IS : 60947
2	Rate insulation voltage (Ui)	:	690 Volts
3	One minute dry withstand test voltage	:	2500 Volts
4	Service (Ics) Breaking capacity at 415V, 50Hz (Ics = 100% Icu)	:	As per BOQ
5	Making capacity	:	As per BOQ
6	Rating of circuit breaker	:	As per bill of material
7	Type of protection relay/release	:	as specified in BOQ
8	Type of tripping mechanism	:	Low power release or specified in BOQ
C	SWITCHGEAR CUBICLES:		
1	Design voltage of switchgear bus	:	415 Volts
2	Clearances (Except Component terminals). a) Between phases b) Between live parts and earth	: : :	 As per IS/IEC
3	Degree of protection (min.) & IK rating	:	IP 42 for indoor Panels & IP 55 for outdoor Panels. IK 10
4	Form of separation	:	As per BOQ
5	Power frequency withstand voltage for complete cubicle	:	2.5KV
6	Method of circuit grounding	:	Solid/flexible copper
7	Space heater details Voltage Ratings Numbers d) Type of controls	 : : : :	 230 V Adequate capacity one per Shipping section Thermostat with MCB.
8	Bus bars		
8.1	Material	:	As per BOQ
8.2	Design	:	Rectangular cross section suitable to take full load current and fault level indicated in BOQ.
8.3	Continuous rating of main bus bars	:	As Per SLD
8.4	Continuous rating of feeder bus	:	As Per SLD

	bars		
9	Temperature rise of the bus bar over the specified design ambient temperature	:	As per IS/IEC.
10	One minute power frequency withstand voltage	:	2.5 KV
11	Ground Bus		
11.1	Material	:	As per BOQ
11.2	Cross Section	:	Sizing as per prospective earth fault current.
12	C.T. Mountings	:	At rear side of the panel
13	Control wire size (Min) :		FRLS PVC Cu wires
13.1	CT circuit	:	2.5 sq.mm. copper
13.2	AC Voltage circuit	:	1.5 sq.mm. copper
14	Painting Procedure	:	With 9 tank sheet treatment and powder coating as per shade indicated in BOQ.
15	Cable entry	:	Bottom / Top as per site condition.
16	Cable compartment door	:	To be provided with hinged doors and knobs
17	Feeder compartment	:	To be provided with hinged doors and knobs
18	Design of switchgear	:	Incomer and bus coupler shall be single tier, outgoing in two tier
19	Quantity	:	As Per SLD

2.4 Construction Features:

The LT switchboards shall be with compartments housing circuit breakers, Control gear, relays, bus bars, controls and other items of equipment as per BOQ. The switchboards shall be designed & manufactured by panel manufacturer or authorized channel partner as per OEM design.

The Switchboards shall be metal clad totally enclosed, floor mounted free standing type of modular extensible design suitable for indoor mounting. The LT panel cubicles shall have structural steel frame work. It is enclosed on all sides and top by CRCA sheet steel of minimum thickness of 1.6 mm.

Intrinsic load bearing member should have min. thickness of 2 mm. The gland plates shall be 3 mm thick CRCA sheet.

The overall height of the switchboard including height base frame of shall be limited to 2475 mm for all the busbar ratings and type of switchboards. The height of the operating handle, push buttons etc. shall be restricted between 300 mm and 2000 mm from finished floor level.

All the doors and covers shall be with full neoprene gasket to prevent any ingress of dust. Door hinges shall be concealed type for compartment doors. However, for wire ways, busbar chambers covers and dropper chamber covers shall be bolted type for safety purpose.
Cable compartments shall be of adequate size for easy termination of all incoming and outgoing cables entering from bottom or top. The construction shall include necessary and adequate and proper support shall be provided in cable compartments to support and clamping the cable in the cable alley / cable chamber.

The MCCB's and Switch Fuse units can be arranged in multi-tier formation. Air Circuit Breakers shall be arranged in Single tier for incomer feeder & not more than two ACBs in each outgoing feeder vertical section.

All Outgoing MCCB/Motor Feeders shall be fixed type mounted on a single base Plate. All components like, circuit breakers, switches etc. shall be compatible with the short-circuit levels.

LED indicating lamps shall be SMD type preferably. All CTs & PTs shall be resin cast unless specified otherwise or as approved by the customer. All relays, meters & switches shall be flush mounted. All metering equipment shall be digital unless specified otherwise in the BOQ.

All holes in metalwork shall be protected by substantial grommets or bushes to protect wiring passing through them. The arrangement of controlling switches in the LV panels and their marking shall be such that these are prominent, easily identifiable and accessible.

Single line power / control diagrams shall be placed at the back of door or other accessible locations in the panels or near to panel with complete details as required. The Switchboard shall be provided with "Danger notice plate" conforming to relevant Indian Standards.

2.5 Bus Bars:

The busbars shall be of hard drawn high conductivity Cu/Al of rectangular cross sections suitable for full load current. The busbars shall be colour coded using identifying colour rings at regular interval. Red, Yellow & Blue colour shall be used for phases & Black for neutral for each shipping section of panels. The earth Busbar shall be identified with Green color rings at regular intervals.

The Busbar sizes shall be determined taking into consideration the continuous rating and fault level indicated, as applicable, without exceeding the temperature raise limits as per IEC, over ambient temperature.

Bus bar supporting systems shall withstand the short circuit forces circuits, without deflection or deformation. The busbars shall be supported at regular intervals using non-tracking SMC or DMC insulators as per the tested design.

Direct access to, or accidental contact with busbars and primary connections shall not be possible.
The busbar system may comprise of a system of main horizontal bus bars and auxiliary vertical bus bars run in busbar chamber on either side in which the circuit could be arranged with front access for cable entrances.

Auxiliary buses for control power supply, space heater power supply or any other specified service shall be provided. These buses shall be insulated, adequately supported and sized to suit specific requirement. Clearances between phases-phases, phase –Earth/ neutral should be in line with IS/IEC.

2.6 Earthing:

One Earthing terminals shall be provided on each side of switchboard. The Cu/Al earth bus size must be sized for prospective earth fault current. The earth bar shall be electrically continuous and shall run the full extent of each board as well as the same side as the cable entry. Each unit shall be constructed to ensure satisfactory electrical continuity between all metal parts which are not intended to be alive.

Suitable holes with bolts and nuts shall be provided at each end of earth bar of switchgear for connection to a main Earthing grid. The earth bar shall be accessible in each cable entering compartment either directly or through a branch extension to ground the cable armor and shields. Door earthing shall be provided for all feeder doors, rear doors and CBC doors with suitable size copper flexible wires.

2.7 Internal Wiring:

The internal wiring shall be FRLS PVC Cu wires of 1100/660V grade. Minimum size of conductor for power circuits shall be 2.5 sq. mm copper. All control wiring except CT secondary wiring shall be carried out with minimum 1.5 sq. mm Copper conductor. CT secondary wiring shall be

carried out with 2.5 sq. mm copper conductor. All wiring shall be securely fixed and neatly arranged to enable easy tracing of wires.

All terminal blocks and wires shall be tagged for identification in accordance with IS 11353.All wiring for external connections shall be brought out to the individual terminals on a readily accessible terminal block. Clamp or screw type control terminal blocks shall be provided for outgoing control cables. Minimum 10% spare terminals shall be provided for future use. Control terminal block shall be separated from power terminal blocks by means of an insulating barrier.

2.8 Space Heaters:

Switchgear enclosures shall be equipped with space heaters of adequate capacity to maintain the internal temperature above the dew point to prevent moisture condensation within the enclosure. Space heater shall be rated for 230 Volts, single phase, 50Hz. A.C. supply. Differential Thermostats shall automatically control the space heaters. ON/OFF and protection should be through adequate rating of MCB for each space heater.

2.9 Illumination:

Each vertical cable/ control compartment shall be provided with LED luminaire, provided with MCB of suitable rating operating on 230 volts, 1 phase 50 Hz AC supply and 5+15A socket with switch to be wired in each compartment.

2.10 Name Plate & Labels:

One name-plate giving designation of the switchboard shall be affixed prominently on top. Details of designation shall be specified.

Labels giving following details shall be affixed on each feeder panel: -
Feeder no as per feeder list
Equipment tag Number Description
Type of Unit (KW/KVA/AMP)

All components whether mounted inside the switchboard or on the door shall be permanently and clearly labeled with reference number and/or letter of their function. Labels for feeder panel designation shall be fixed on the front side of respective panels.

2.11 Painting:

All steel work shall undergo a process of degreasing, pickling in acid bath, phosphating, passivating & shall be subjected to nine tank process and then Powder coated with approved shade as per BOQ.

2.12 Inspection and Testing:

Inspection and testing of the panel shall be carried out at works of manufacturer in presence of Department representatives:

Inspection: The inspection shall consist of following, but shall not be limited to the same –

i. Appearance and construction.
ii. Dimensions, mounting details etc.
iii. Feeder arrangement and feeder details.
iv. Door alignment, gaskets etc.
v. Alignment of switch drive and handle.

2.13 Tests:

The following tests shall be carried out:

2.14 Insulation resistance:

The insulation resistance shall be measured between phases, between phase and neutral and between phase and earth. The insulation resistance shall be measured with 1000Volts megger, both before and after high voltage power frequency test. The insulation resistance shall not be less than three Mega-Ohm in any case.

2.15 High voltage power frequency test:

This test shall be carried out by applying a voltage of 2.5KV for one minute.

i. between all three phases and earth.
ii. between the phases.
iii. between phases and neutral.

2.16 Heat run test shall be carried out on the panel if specified in BOQ. The heat run test shall be carried out as one panel of each different rating. The selection of the panel on which heat run test shall be carried out shall be decided by Engineer-in-charge.

If the result of inspection and tests are not satisfactory, the defects shall be rectified and tests shall be repeated to entire satisfaction of Engineer-in-Charge without any extra charge to employer. The inspection and tests result shall be submitted in quadruplicate for engineer-in-charge approval.

All type test certificates conducted on similar type complete switchgear assembly as per IS/IEC 61439 shall be submitted during the drawing approval process.

2.17 Installation of Switchgear Panels:

Installation, testing and commissioning at site of switchgear panel as per specification shall be carried out. The switchgears are to be installed on the grouted base frame on floor / over trench. Department shall approve the drawing of the base frame and including positioning, leveling, proper alignment of panel, inter-panel connection, extension of bus bars with all required accessories for grouting remaking it with PCC as per site. Necessary chipping and PCC work, for installation of switchgear panels, as directed by E-I-C at site, including all necessary anchor fasteners etc. complete.

MS channel (ISMC 100) required for installation of panel on cable trench including cutting of chequered plate cover etc. is included in the scope of work.

The following pre commissioning tests shall be carried out on the panels:
Electrical and mechanical operations of circuit breaker

i. Functional test of CB
ii. Insulation Resistance.
iii. Testing of relays/release
iv. Checking of all electrical connections, electrical and mechanical interlocks.
v. Inter changeability of breakers as desired by Engineer-in-Charge at site.

2.18 Drawings & operating manuals:

The following drawings shall be submitted for Engineer-in-charge approval before taking up the fabrication:

Complete assembly drawings of the switchgear showing plan, elevation and typical sectional view.

Panel base plan showing locations of channel sills, foundation bolts and anchors, floor plans and openings.

Complete wiring diagram including terminal wiring designations.

Schematic control diagram both AC and DC for breaker control, interlocks, relays, instruments and space heaters.

Complete terminal block details, showing ferrule numbers wire destinations.

The following shall be submitted on delivery of panels:
i. 4 Nos. of installation and operation manual
ii. 4 Nos. of all as built drawings.
iii. 6 Nos. of operating handles.
iv. Reproducible drawings on Compact Disc.

B. AUTOMATIC POWER FACTOR CONTROL PANEL (APFC) WITH CAPACITOR BANK

2.19 Scope:

This specification covers supply, installation and testing of automatic power factor control panel (APFC) along with 415 Volts shunt capacitor bank. Associated minor civil works are included in the scope of this contract.

2.20 Standards:

The equipment covered under this specification shall conform to the latest revisions of relevant Indian and International Standards some of which are listed below:

IS/IEC 61439	Low voltage switchgear and control Gear assemblies
IS 13340/IEC 60831	Shunt power capacitors of the self-healing type for ac systems
IS /IEC 60947	General requirements of Switchgear and Control Gear for Voltage not exceeding 1000 / 1200V AC
IS 2705 1992	Current transformers
IS 694 1990	PVC insulated cables for voltages including 1100 V with Copper and Aluminium Conductor).
IS 5082	Electrolytic Aluminium Busbar, Trunking system, Rod tubes & sections for Electrical Purposes
IS 13779 1999	AC Electric Meters / Static Meters.
IEC 60529	Degree of Protection

2.21 Constructional Data for APFC:

The APFC switchboards shall be with compartments housing Capacitor banks, circuit breakers, Control gear, relays, bus bars, controls and other items of equipment as per BOQ. The switchboards shall be designed & manufactured by panel manufacturer or authorized channel partner as per OEM design.

The Switchboards shall be metal clad totally enclosed, floor mounted free standing type of modular extensible design suitable for indoor mounting. The cubicles shall have structural steel frame work. It is enclosed on all sides and top by CRCA sheet steel of minimum thickness of 1.6 mm.

Intrinsic load bearing member should have min. thickness of 2 mm. The gland plates shall be 3 mm thick CRCA sheet.

The overall height of the switchboard including height base frame of shall be limited to 2475 mm for all the busbar ratings and type of switchboards. The height of the operating handle, push buttons etc. shall be restricted between 300 mm and 2000 mm from finished floor level.

All the doors and covers shall be with full neoprene gasket to prevent any ingress of dust. Door hinges shall be concealed type for compartment doors. However, for wire ways, busbar chambers covers and dropper chamber covers shall be bolted type for safety purpose.

Cable compartments shall be of adequate size for easy termination of incoming cables entering from bottom or top. The construction shall include necessary and adequate and proper support shall be provided in cable compartments to support and clamping the cable in the cable alley / cable chamber.

All steel work shall undergo a process of degreasing, pickling in acid bath, phosphating & shall be subjected to seven tank process and then Powder coated with approved as per BOQ.

By selection of 'mode selector switch (MSS)' in the panel it shall be possible to operate APFC either in 'auto mode' or full 'manual mode'.

For 'auto mode', 10/8 step power factor (PF) control relay unit to be provided in APFC incomer portion. This relay shall have following features:

Power factor indication, digital to indicate actual system power factor.
Power factor setting dial calibrated from about 0.85 lag to 0.85 lead.
Dead band feature (adjustable) to prevent hunting.

Under current blocking, to switch OFF all capacitors one by one and shutting down of relay, when load current is below 20% with appropriate indication available on the relay.

Low PF and high PF indication.

When the power factor falls below the setting, the capacitor bank shall be switched ON, in sequence at intervals of 4 to 8 seconds minimum and when the power factor rises above the setting, capacitor banks are switched OFF in sequence. The sequence of switching ON and OFF shall be as follows:

Switching ON: Bank 1, 2, 3.....8, 9, 10
Switching OFF: Bank 1, 2, 3..... 8, 9, 10

The relay shall provide feature to provide an adjustable delay of about 0-120 seconds from changeover from 'capacitor OFF' signal to 'capacitor ON' signal, to ensure the capacitor are fully discharged before they are switched in, to prevent dangerous transient over voltages.

The relay shall provide 'LED' indications, to indicate to the operator the full status of relay like auto-manual, load signal healthy and above the minimum operating threshold, low and high power factor, lest mode, indication for the bank switched ON and any other 'LED' necessary for operator convenience and safe/proper operation.

The relay shall be flush mounting type on the APFC door and shall have conveniently removable transparent glass or acrylic cover, also avoiding inadvertent/un-authorized tampering of relay controls, once set.

If mode selector switch is kept in 'manual' mode it shall be possible to switch the capacitor banks ON and OFF in any sequence, through push buttons provided for each bank. Each bank shall also be provided with ON indication lamp. In the 'manual' mode the following features shall be present:

Between switching ON operation of banks there shall be time delay of about 70 seconds.

Similar time delay shall be present from bank switching OFF to bank switching ON to ensure full discharged capacitor condition, to prevent dangerous system disturbances.

The time delays as above shall be adjustable from 0-120 seconds.

A common indication lamp, 'ready for manual switching', dependent on the timer shall indicate to the operator the readiness of the bank for switching-ON.

The manual operation of APFC shall be available as described even in the case of failure of power control relay.
An emergency, stay put type mushroom-head push button 'emergency OFF' shall be available to de-energise all the contactors and also switch-OFF the incoming MCCB both in auto and manual position of mode selector switch.

The control voltage of APFC shall be 240 Volts A.C/110V D.C. MCB /fuses shall be used in the control circuits for protection and isolation.

SAFETY ANNUNCIATION FEATURES OF APFC PANEL:

The APFC shall have the following: -
Two tone hooters
Fault indication lamp
APFC out of circuit indication lamp
All located at the top portion of the panel.

If MCCB is kept OFF or trips during its operation, the hooter should come ON along with lamp and continue to operate till accept push button, present on the APFC, is pressed to cancel the audio/visual alarm. However, the APFC out of circuit lamp will continue to flash till the MCCB is closed and APFC is put in operation, drawing attention of operators to the situation.

The flashing feature is to be derived by adjustable cyclic timer - electronic type, 0.6 seconds to 60 seconds set at 2 seconds.

Audio/visual annunciation facility with an electronic hooter and two lamps shall be provided as part of central control console. Necessary terminals in the APFC shall be foreseen for this purpose.

2.22 CONSTRUCTIONAL DATA FOR CAPACITOR BANK:

The capacitor banks shall be provided with suitable capacity as per S.O.Q. Each capacitor unit shall be a three-phase unit suitable for delta connections. Each capacitor unit shall consist of capacitor elements connected in parallel. Each unit shall be protected by internal fuse.

The capacitor unit shall be housed on a leak proof bank. The capacitor shall be APP type with 7% detuned reactor or as per manufacturers standard material and then dried both under high degree of vacuum. The capacitor unit shall be provided with the discharge resistors to reduce the phase voltage to 50 Volts within one minute. Each capacitor unit shall be provided with 2 nos. earthing terminals.

The capacitor unit shall be banked together. They shall have common base frame and a cover shall be provided to prevent the accidental contact with the terminals. Adequate space shall be provided for connecting each capacitor unit. Each capacitor unit shall be provided with a rating plate. The capacitor unit shall be suitable for indoor application. Electromechanical relays used shall not be plug in type.

2.23 INSPECTION AND TESTING:

Inspection shall consist of the following, but shall not be limited to the same –
Appearance and construction.

Dimensions, mounting details.
Leakage container and at the bushing.

2.24 TESTS:

The following routing tests shall be carried out as per relevant IS/IEC

i. Test for output and capacitance.
ii. Voltage test between terminal and container (for capacitor unit).
iii. Voltage test between terminal and earth (for capacitor bank).
iv. Insulation resistance test.
v. HV test
vi. Test for efficiency of discharge device.

If the results of the inspection and tests are not satisfactory, the defects shall be rectified and tests shall be repeated to the entire satisfaction of department without extra charges whatsoever.

The inspection & test results shall be submitted in quadruplicate for Department's approval.

2.25 INSTALLATION OF SWITCHGEAR PANELS:

Installation, testing and commissioning at site of APFC panel as per specification shall be carried out. The switchgears are to be installed on the grouted base frame on floor / over trench. Department shall approve the drawing of the base frame and including positioning, leveling, proper alignment of panel, inter-panel connection, extension of bus bars with all required accessories for grouting remaking it with PCC as per site. Necessary chipping and PCC work, for installation of switchgear panels, as directed by E-I-C at site, including all necessary anchor fasteners etc. complete.

MS channel (ISMC 100) required for installation of panel on cable trench including cutting of chequered plate cover etc. is included in the scope of work.

The following pre commissioning tests shall be carried out on the panels:
vii. Electrical and mechanical operations of circuit breaker
viii. Functional test of CB
ix. Insulation Resistance.
x. Testing of relays/release
xi. Checking of all electrical connections, electrical and mechanical interlocks.
xii. Inter changeability of breakers as desired by Engineer-in-Charge at site.

2.26 DRAWINGS:

The following shall be submitted in quadruplicate for E-I-C's approval: -
i. Guaranteed technical particulars for capacitors.
ii. Dimension drawings and foundation details.
iii. Test certificate for type tests.

3.0 DISTRIBUTION BOARDS

3.1 SCOPE:

The specification covers design, manufacture, testing and commissioning of fabricated lighting / power distribution boards. (Readymade DB to be supplied & installed as per the preferred makes of material & Schedule of Quantity.)

3.2 STANDARDS:

The design, manufacture and testing of lighting/power distribution board shall comply with the latest issue of following standards:

IS - 61439	:	Low-voltage switchgear and control gear assemblies - part 3 distribution boards intended to be operated by ordinary persons (dbo)
IS - 60529	:	Degree of protection provided by enclosure for low voltage switchgear.
IS 60947	:	LV switchgear
IS 12640	:	Residual current operated circuit- breakers without integral overcurrent protection (RCCB) / with integral overcurrent protection (RCBO) for household and similar uses
IS 14614	:	Residual current-operated protective devices RCDs for household and similar use electromagnetic compatibility
IS 60898	:	Electrical accessories-circuit-breakers for overcurrent protection(MCB) for household and similar installations

3.3 Construction:

Lighting/power distribution board shall be cubical type suitable for wall mounting or recessed mounting. It shall be totally enclosed, completely dust proof & vermin proof & shall have min. IP-42 degree of protection.

Sheet steel work shall be of high quality and shall be free from burrs. Sheet steel used for the body and door shall be as per manufacturers standard.

Lighting/power distribution board shall have one concealed hinged door which will cover the entire front portion. The door shall be provided with gasket to make the equipment dust tight and also with insulated quick turn screws.

Design shall be dead front type. No live components shall be mounted on door. Adequate space shall be provided for termination of aluminium cables and wires.

The DBs shall be with double door design, with all components to be mounted on removable base plate. The recess mounting DBs shall be provided with two hold fast arrangement. i.e. DBs shall be provided for wire way box at incomer /outgoing, as applicable.

3.4 BUSBARS (wherever applicable):

Tinned copper busbars shall be provided with suitable insulation covers and supports of epoxy material (non-hygroscopic anti tracking material) as per manufacturer standard.

3.5 WIRING AND TERMINAL:

The lighting/power distribution board shall be factory wired. Flexible copper wires shall be used for internal wiring. For neutral terminals, brass neutral terminal block shall be provided. It should have spare capacity of at least 10% or as per manufacturers standard.

3.6 CABLE ENTRY

Cable entry for incomer shall be from bottom/top but entry for outgoing circuit shall be from top. Removable sheet steel plates shall be provided for conduit entry/cable entry. Compression type plate brass cable gland shall be provided for incoming/outgoing cables. Wire way boxes shall be provided at incoming /outgoing side.

3.7 EARTHING:

Two numbers earthing terminals shall be provided on either side of the lighting/power distribution board.

3.8 INSPECTION AND TESTING:

3.8.1 Inspection:

The inspection shall consist of following, but shall not be limited to the same –

i. Appearance and construction.
ii. Dimensions, mounting details etc.
iii. Feeder arrangement and feeder details.
iv. Door alignment, gaskets etc.

3.8.2 Tests:
The following tests shall be carried out –

i) Insulation resistance:

both before and after high voltage power frequency test. The insulation resistance shall not be less than two megaohm in any case.

ii) High voltage power frequency test:

a) between all three phases and earth.
b) between phases.
c) between phases and neutral.

If the result of inspection and tests are not satisfactory, the defects shall be rectified and tests shall be repeated to entire satisfaction of engineer-in-charge/consultant without any extra charge to employer. The inspection and tests result shall be submitted in quadruplicate for engineer-in-charge/consultant's approval.

4.0 UPS SYSTEM WITH BATTERY BACK UP

4.1 Scope of Work:

Supply, installation, testing & Commissioning of UPS system with battery backup, Cabling, Earthing etc as per detailed BOQ.

4.2 Reference Codes & Standards:

The UPS and all associated equipment and components shall be manufactured in accordance with the following applicable standards. The equipment shall comply with the requirements of latest revision of following standards issued by BIS (Bureau of Indian standards) unless otherwise specified.

- IS-1248 - Direct acting indicating analogue electrical measuring (Part 1, 2, 4, and 9) instruments and their accessories.
- IS/IEC 60529 - Degree of protection provided by enclosures for low voltage switchgear and control gear.
- IS-3700 - Essential ratings and characteristics of semi-conductor devices.
- IS-3715 - Letter Symbols of semi- conductor devices. (Part 1 to4)
- IS-12021 - Control transformers for switchgear and control Gear for voltages not exceeding 1000V AC
- IS-13314 - Solid state inverters run from storage batteries
- IS-13703 - Low voltage fuses for voltage not exceeding 1000V AC or 1500V DC

- IS- 13947 - Specification for low voltage switchgear and (Part-4/Sec-1)
- control gear
- IS- 1651 - Lead Acid Tubular Type Batteries
- IS 15549 - Stationary valve regulated lead acid batteries
- IS- 2026 Part 11 - Dry type transformers
- EN 50091
- IEC 62040
- IEC/EN 60146

4.3 UPS Configuration:

UPS shall be true online double conversion type and shall comply with **the classification VFI SS 111 as per IEC 62040-3.**

The UPS shall be modular hot swappable rack mounted scalable array architecture/ conventional (as per BOQ). The bypass input to the UPS shall be derived from the Main primary input.

4.4 UPS System Components:

The UPS shall contain fully rated input rectifier,boost converter, output inverter & battery charging circuits. The brief functional description of components are as follows:

a.) **Fully microprocessor controlled IGBT rectifier:**

The rectifier/charger is the solid-state equipment with controls, necessary to convert incoming AC power to regulated DC power for input to boost conveter/ inverter and for battery charging. The rectifier shall be with IGBT technology & shall give high power and fast switching, less drive power & small power losses, over current & over temperature protection, control power failure and short circuit protection etc.

Power semiconductors in the rectifier/charger shall be fused with fast-acting fuses, so that loss of any one-power semiconductor shall not cause cascading failures.

The rectifier/charger shall have an output filter to minimize ripple voltage into the battery. Ripple voltage to the battery shall not exceed 1% RMS. The filter shall be adequate to ensure that the DC output of the rectifier/charger will meet the input requirements of the inverter. The inverter shall be able to operate from the rectifier/charger with the battery disconnected.

In addition to supplying power for the inverter load, the rectifier/charger shall be capable of producing battery-charging current to recharge the battery. After the battery is recharged the rectifier/charger shall maintain the battery at full charge until the next emergency operation.

b.) **Fully microprocessor controlled IGBT based Inverter :**

The inverter is the solid-state equipment with controls, to convert DC power from the rectifier/charger or battery to regulated AC power, for supporting the critical load. The inverter shall be an IGBT based design capable of providing the specified AC output & shall give high power and fast switching, less drive power & small power losses, over current & over temperature protection, control power failure and short circuit protection etc.

The inverter shall be capable of supplying current and voltage for overloads exceeding 100% and up to 150% of full load current. A status indicator and audible alarm shall indicate overload operation. The UPS shall transfer the load to bypass when overload capacity is exceeded.

c.) **Full capacity static switch at the output of the inverter & bypass path :**

Static transfer switches and bypass circuits shall be provided as an integral part of the UPS. The static switches shall be rated to conduct full load current continuously and shall enable the critical load to be connected to the inverter output or bypass power source. The static transfer switch control logic shall contain an automatic transfer control circuit that senses the status of the inverter logic signals, and operating and alarm conditions.

The transfer control logic shall automatically turn on the static transfer switch, transferring the critical AC load to the bypass source, after the transfer logic senses any of the following conditions:

- Inverter overload capacity exceeded.
- Critical AC load over voltage or under-voltage
- UPS fault condition.

The transfer control logic shall inhibit automatic transfer of the critical load to the bypass source until of the following conditions are met by control logic of UPS:

- Inverter/bypass voltage difference within pre-set limits
- Bypass frequency within limits
- Bypass in synchronization range with inverter output.

Retransfer of the critical AC load from the bypass source to the inverter output shall be automatically initiated unless inhibited by manual control. The transfer control logic shall inhibit an automatic retransfer of the critical load to the inverter until the following conditions are met by control logic of UPS:

- Inverter/bypass voltage difference within pre-set limits
- Bypass frequency within limits
- Bypass in synchronization range with inverter output.
- Overload condition exists in excess of inverter full load rating / UPS fault condition present.

d.) **Full capacity Circuit breaker for battery :**

A battery circuit breaker shall be provided to isolate the battery from the UPS. This breaker together with battery circuit breaker controller board shall be mounted in separate enclosure of UPS frame or as per manufacturers standards. The battery breaker provides a manual disconnecting means, short circuit protection, and over-current protection for the battery system. When opened, there shall be no battery voltage in the UPS enclosure. The DC protection shall be ensured by a circuit breaker with under voltage trip coil to isolate the Battery Bank from UPS during fault at the either side of the DC bus. It shall provide protection against deep discharge of the batteries by automatically disconnecting battery bank from UPS.

e.) **Full capacity Manual Bypass Switch :**

A manually operated maintenance bypass isolator shall be incorporated into the UPS cabinet or as per manufacturer standard to directly connect the critical load to the input AC power source, bypassing the rectifier/charger, inverter, and static transfer switch.

With the critical load powered from the maintenance bypass circuit, it shall be possible to check out the operation of the rectifier/charger, inverter, battery, and static transfer switch.

f.) **Battery as per BOQ:**

Batteries shall have a minimum life of 5 years. The inter connection between batteries shall be carried with appropriate size of copper cables.

g.) Isolation transformer shall be provided at load end as per BOQ.

4.5 Modes of Operation:

The UPS system shall operate as a true on-line system in the following modes:

a.) Normal mode:

The critical server load is continuously powered by the UPS inverters. The rectifier/ chargers derives power from the mains AC power supply source converting this to DC power to supply the inverters, while simultaneously float charging the battery system. Power supplied by the UPS inverters is, to within close tolerances, at rated voltage and frequency.

b.) Emergency/ Battery mode:

Upon failure of the mains AC power supply source, the critical AC load is powered by the inverters which, without any switching, obtain power from the battery system. There shall be no interruption in power to the critical load upon failure or restoration of the mains AC power supply source.

c.) Recharge mode:

Upon restoration of the mains AC power supply source, power to the rectifier/ chargers initially is restricted by a gradual power walk-in. Following this relatively short power walk-in period, the rectifier/ chargers power the inverters and simultaneously recharge the battery. This shall be an automatic function.

d.) Bypass mode:

In the event of an inverter overload, which last longer than the specified time, an output short circuit or a fault on the inverter, the UPS shall transfer the load to bypass. There shall be two kinds of bypass modes. In the first kind, the UPS shall be set to return to normal mode automatically when the load decreases. In the second kind, the UPS is set to return to normal mode only with a manual transfer. When the main UPS circuit fails or a severe fault occurs, the system will remain in the bypass mode. The system shall return to normal mode only with a manual reset after the fault is cleared.

e.) Maintenance bypass mode:

When the UPS has to undergo routine maintenance, the UPS shall be set to maintenance mode by switching ON the maintenance bypass circuit breaker. The load shall be powered from the maintenance bypass supply without interruption.

4.6 Technical Parameters:

Sr. No.	Parameters	Specifications
A.	UPS Capacity	AS per BOQ
B.	No. of UPS & Configuration	1) True online double conversion UPS in standalone configuration & having modular hot swappable rack mounted scalable array architecture. 2) UPS capacity shall be configured with hot swappable modules as per manufacturer's standard. Space provision shall be available to scale modules in future.

Sr. No.	Parameters	Specifications
C.	Classification of UPS as per IEC 62040-3	VFI SS 111
1.0	**Input:**	
1.1	Nominal Voltage	415V, 3 phase 4 wire
1.2	Input Voltage variation	+ 10% , -15%
1.3	Nominal Frequency	50 Hz
1.4	Input Frequency variation	+/- 10 %
1.5	Input Power factor	'> 0.97
1.6	Input Current	Shall be limited to 125% of system capacity.
2.0	**Battery:**	
2.1	Type of Batteries	AS per BOQ
2.2	Battery backup time	As per BOQ
2.3	Battery breaker enclosure with MCB/MCCB	To be provided in separate enclosure of UPS frame.
3.0	**Output:**	
3.1	Nominal Voltage	415V, 3 phase & neutral
3.2	Voltage regulation	+/- 1 %
3.3	Nominal frequency	50 Hz, +/- 0.05Hz
3.4	Frequency Slew rate	< 1 Hz/sec.
3.5	Load Power factor Compatibility	Lagging or leading >=0.9
3.6	Overload Capability	125% for 10 minutes. 150% for 1 minute.
4.0	**Environmental Condition:**	
4.1	Location	Indoor
4.2	Protection Degree	IP 20
4.3	Ambient temperature	0-40^0 C
4.4	Max. relative humidity	< 95%
4.5	Overall efficiency	min. 96%
5.0	**Additional UPS features desired, but not limited to following:**	
5.1	Battery Management function	The UPS shall have battery management functions including battery fault detection, backup time forecast & available battery life.
5.2	Soft Start function	The surge to the UPS unit from utility source shall be reduced by complete delay soft start function.
		The Power walk in (time required for UPS to take rated load at the time of starting) shall be 1 Sec. through 30 seconds.
5.3	Metering & Alarm	The UPS shall be provided with microprocessor-based unit status display, metering & alarm for convenient & reliable user operation. The list of such metering, alarm parameters shall be submitted.
5.4	BMS Connectivity	Each UPS shall have RS 485 port for BMS interface & RJ-45 for LAN connectivity over Ethernet on Modbus/SNMP protocol

4.7 UPS Construction:

The UPS unit shall be housed in a free standing steel enclosure with key-lockable doors. The enclosure shall be fabricated with cold rolled sheet and structural steel for chassis, covers & partition sheets as per manufacturer standard. Hinged doors shall be provided at the front and back wherever required, with dust tight neoprene gaskets. The enclosure will be built to comply with IP20 when the doors are open. All the cable entries in the UPS enclosure shall be from top/bottom only.

The UPS cabinet shall be powder coated as per manufacturer's standard. The UPS shall be constructed of replaceable subassemblies.

Cooling of the UPS shall be forced-air. Low velocity fans shall be used to minimize audible noise output. Fan power shall be provided by the UPS output. Temperature will be monitored by thermal sensors.

4.8 Isolation Transformer as per BOQ:

Isolation transformers are proposed at the load end in order to retain the neutral to earth voltage at desirable levels. The Isolation transformer allows use of harmonic rich non-linear loads while maintaining safe operating temperatures and gives superior transverse and common mode noise attenuation along with transient spike attenuation. **The transformer shall be rated for 'K' factor of 13 as per UL 1561 standard.**

Transformer shall be copper wound, multi-shielded, three phase delta connected input and three phase star connected output with neutral available for connection, 600 volt class, convection air cooled, dry type, continuous duty.

Terminals shall be provided for isolated three phase output conductors, neutral conductor and ground.

Cabinets shall be manufactured from MS CRCA steel with base sub-structure adequate for fork lifting.
The cabinet shall be powder coated as per manufacturers standard.
The nominal AC input voltage rating of the transformer shall be 415VAC, three phase with sufficient margin to sustain a constant input of +10% without saturation.

Frequency 50 Hz +/-3 %

Temperature - Transformers shall be required to operate without overheating in an ambient temperature range of -20 degrees Celsius to +50 degrees Celsius.

Humidity - Transformers shall operate in a relative humidity of 0 to 95% non-condensing.
The transformer shall have an efficiency more than 95%.

Audible noise - Maximum allowable noise level shall not exceed 50dBA when measured at one-meter distance.

Transformer shall have Input breaker for protection and isolation purpose with digital metering to monitor the parameters.

4.9 Testing:

The routine & acceptance tests as per IEC 62040 shall be carried out on UPS, in manufacturers works, in presence of departmental representative. The following acceptance test shall be offered on UPS:

i. Interconnection Cable Check.
ii. Light load test.
iii. UPS Auxiliary device test.

iv. AC input failure test.
v. AC input return test.
vi. Transfer & re-transfer test.
vii. Line regulation test.
viii. Load regulation test.
ix. Harmonic component test.
x. UPS efficiency test.
xi. Overload capacity test.
xii. Unbalance load test.

The routine & acceptance testing of batteries, shall be separately carried out at battery manufacturers works & witnessed by departmental representative.

The routine & acceptance testing of dry type transformer as per IS 2026, shall be separately carried out at transformer manufacturers works & witnessed by departmental representative.

4.10 Drawings:

The Bidder shall submit the General arrangement and single line diagram along with the offer and also during drawing approval stage.

The Bidder shall submit the following drawings for approval of the department after placement of the order but before taking up the fabrication work:

i. GA drawings indicating make of the components.
ii. Power & control schematic drawings.
iii. Layout of the battery bank in battery room.
iv. copies of test certificates and 6 copies of descriptive literature, catalogues and instruction manual shall be submitted by the Bidder.

5.0 WIRING INSTALLATIONS & ACCESSORIES

5.1 Scope:

This specification covers supply, erection, testing and commissioning of mains/sub-mains/power wiring, point wiring, wiring accessories, fittings and fixtures etc. as detailed under Bill of Quantities/ specific requirements.

5.2 Standards and codes:

The design, manufacture, erection, testing and commissioning shall comply with, but not limited to the latest issue of the following standards and rules: -

IS - 4648	:	Electrical layout in residential buildings.
IS - 14927	:	Specification for UPVC Trunking for electrical wiring
IS - 694	:	PVC insulated cables with copper conductors for voltages upto 1100 Volts
IS - 732	:	Code of practice for electrical wiring installation (system voltage not exceeding 650Volts)
IS 17048 : 2018	:	Halogen Free Flame Retardant (HFFR) Cables for Working Voltages Up to and Including 1100 V
IS 3961 (Part 5):	:	Recommended current ratings for cables
IS - 1646	:	General code of practice for fire safety of bldg.- electrical installation
IS - 3043	:	Code of practice for Earthing
IS 1258	:	Bayonet Lamp Holders
IS-3854	:	Switches for domestic and similar purposes.
IS-1293	:	Three pin plugs and socket outlets.
IS-371	:	Ceiling Roses.

IS-2268	:	Electrical call bells and buzzers for indoor use.
IS-9537		Conduits for Electrical Installations
IS 3419		Specifications for fittings for rigid non-metallic conduits
SP-30	:	NEC 2023

Indian Electricity Rules 1956, Indian Electricity Act 2003, NBC-2016 as amended up to date and local supply authorities' rules & regulations.

5.3 Introduction

i. The wiring shall be done from a distribution system through main and/or branch distribution boards.
ii. Each main distribution board and branch distribution board shall be controlled by an incoming circuit breaker. Each outgoing circuit shall be controlled by a circuit breaker.
iii. For non-residential and residential buildings as far as possible DBs shall be separate for light and power or as specified in BOQ.
iv. Only MCCB/MCB type main and branch distribution boards shall be used. HRC/ Rewireable type fuses shall not be used.
v. 'Power' wiring shall be kept separate and distinct from light wiring, from the level of circuits, i.e., beyond the branch distribution boards. Conduits for light/power wiring shall be separate if the distribution boards are separate.
vi. Essential/non-essential/UPS distribution each will have a completely independent and separate distribution system starting from the main, switchboard upto final wiring for each system. As for example, conduit carrying non-essential wiring shall not have essential or UPS wiring. Wiring for essential and UPS supply will have their own conduit system. No mixing of wiring is allowed.
vii. Generally, no switchboard will have more than one source of incoming supply. More than one incoming supply will be allowed only at main board with proper safety and interlocking so that only one source can be switched on at a time.
viii. Each MDB/DB/Switch Board will have reasonable spare outgoing ways for future expansion.
ix. Balancing of loads on 3-phase circuits shall be done.
x. Submain Wiring: Submain wiring shall mean the wiring from Meter box/MDB to Distribution board. Submain wiring shall be measured on linear basis along the run of the wiring. The measurement shall include all lengths from end to end of conduit or channel as the case may be, excluding interconnections inside the switchboard etc.
xi. Conduit carrying Submain will not carry circuit / point wiring. Similarly, conduit carrying point wiring / circuit wiring will not carry Submain.
xii. Wires of point wiring of different phases shall not be routed in same conduits/ casing capping.

5.4 Point Wiring:

Point wiring shall include all the work necessary to complete the wiring of any length from MCB of the distribution board (DB) & upto the following outlets via their controlling switches on switchboards:

i. Ceiling rose or connector
ii. Back plate (in case of stiff pendants and fluorescent fittings with down rods etc.)
iii. Socket outlets
iv. Ceiling Fan / Fan regulator
v. Lamp Holder
vi. Call bell / Buzzer etc.

The following shall be deemed to be included in point wiring:

1. Installation of conduits / PVC casing & capping.
2. Installation of recessed GI switch boxes / MS surface boxes.

3. Drawing of copper conductor insulated wires (Phase+Neutral+Earth) of suitable sizes including termination on both sides with suitable sizes of tinned copper lugs.
4. Providing Ferrule numbers on both sides of wires for labeling etc.
5. Installation of controlling switches / sockets / fan regulators, cover plate with frame, ceiling rose, PVC square box, Junction box, PVC round plates etc.
6. Installation of all fixing accessories such as GI screws, Clips, Phil plug compound, Rawl plug, Wooden plugs, bend, elbows, couplers etc. saddles & spacers as required.
7. Connection of wires to ceiling rose, connector, socket outlet, lamp holder, switch, fan regulator etc. with suitable copper lugs / connectors.
8. Interconnecting wiring between switches within the switch box on the same circuit.
9. Providing bunching tags for wires inside casing capping at the intervals of 600 mm to avoid hanging of wires.
10. PVC conduit glands/ double check nuts at conduit terminations. Terminal blocks at switch boards and junction boxes.
11. Drilling holes in the walls if required, providing PVC sleeves for crossing of the wall & refinishing of wall with white cement.
12. The cables shall conform to IS: 697. For all internal wiring FRLS insulated copper cables of 650/1100 volts grade, single core shall be used.
13. The conductors shall be plain annealed copper conductors complying with IS: 1554.
14. The conductors shall be circular copper conductor.
15. The insulation shall be FRLS compound complying with the requirements of IS: 697. It shall be applied by an extrusion process and shall form a compact homogenous body.
16. The thickness of FRLS insulation shall be as set out in the relevant standards.
17. The cores of all cables shall be identified by colours in accordance with the following sequence.

Single phase	Red
Three phase	Red, Yellow, Blue
Neutral	Black
Earth	Green or Green/Yellow

18. Means of identifying the manufacturer shall be provided throughout the length of cable.
19. Unless otherwise specified in the drawings the size of the cables used for internal wiring shall be as follows:

- In case of circuit wiring for lights, exhaust fans, ceiling fans, bell, convenience socket outlet points (P+N+E):

2.5sq.mm.	From D.B. to switch boards.
1.5sq.mm.	From switch boards to outlet points

- In case of power socket outlet circuit having not more than two 15 A power outlet (P+N+E):

2.5sq.mm.	From D.B. to power outlet

- In case of power socket outlet circuit having single 15 A power outlet (like water heater) (P+N+E):

4.0sq.mm.	From D.B. to power outlet.

- In case of 15 A. power outlet for window Air conditioner or other likewise appliances (P+N+E):

4.0sq.mm.	From D.B. to power outlet.

20. The earth continuity conductor shall be similar to circuit cables and shall be drawn through conduit along with other circuit cables. The size of the earth continuity conductor shall be as follows:

MINIMUM SIZE OF EARTH CONTINUITY CONDUCTOR NOT FORMING PART OF THE SAME CABLE AS THE ASSOCIATE CIRCUIT CONDUCTOR

Nominal cross-section area of largest associated copper circuit conductor in sq.mm.	Nominal cross-sectional area of earth continuity conductor in sq.mm.
1.5	1.5
2.5	1.5
4.0	2.5

21. Switch

1. Switches shall conform to IS: 3854, IS: 1293 and IS: 4615. The switches shall be single pole, single or two way as shown on the drawings or as specified. They shall be of moulded type rated for 250 volt, and of full 5/15 A capacity. They shall be provided with insulated dollies and covers

2. The switches shall be rocker operated with a quiet operating mechanism with bounce free snap action mechanism enclosed in an arc resistant chamber.

3. The switches shall have pure silver and silver cadmium contacts.

4. The switches shall be flush modular type.

5. The make of the switches shall be as indicated in the drawings or BOQ or make of material or as suggested and approved by the client.

6. The switches installed in outdoor area shall be industrial, metal clad type, and shall be provided in weatherproof enclosures, complete with weatherproof gasketed covers.

22. Socket

1. The sockets shall conform to IS: 1293. Each socket shall be provided with control switch of appropriate rating. The sockets shall be moulded type, rated for 250 volts, and either of full 5 A or 15 A capacity, as mentioned on the drawings.

2. Sockets shall be of three pin type, the third in being connected to earth continuity conductor.

3. The socket shall be flush modular type.

4. The sockets installed in machine room, plant room or wet/damp area shall be metal clad weatherproof type.

5. The finishing and make of all the sockets shall be same as light switch.

6. The socket shall have fully sprung contacts and solid brass shrouded.

7. Terminals to ensure positive electrical connections.

8. The sockets shall be provided with automatic shutters, which open only when earth pin of the plug inserts in the socket.

9. The socket shall be provided with three pin plug top suitable to the socket and of the same make as socket.

- *Unless and otherwise specified, there shall be no linear measurement for point wiring. It shall be measured on unit basis by counting.*

- *Earth wire shall be looped in all the switchboards present in the premises.*

5.5 Types of point wiring:

5.5.1 Lighting circuit –

- In installations, Light point, Ceiling Fan point, Plug Point (6A socket outlet), Exhaust Fan point & Call bells point shall be wired in a common circuit & such circuit shall be called as lighting circuit. Each circuit shall not have more than 800 W connected load or more than 10 no. of points, whichever is less.

Independent Earthing from DB shall be provided for lighting circuit of each room.

5.5.2 Power Circuit –

- Independent circuit including earth wire shall be provided from distribution board for each Power Point (16A socket outlet) / Water heater point / A.C. point. The load of such circuit shall be restricted to 3000 watts.

- Power circuit shall have only one outlet per circuit. However, for computer points in non-residential buildings, 3 nos. of 6A socket outlets controlled by 16Aswitch can be fed through power circuit.

5.5.3 Ratings of Outlets

i. LED fittings shall be rated as per actual.
ii. Conventional Ceiling fans shall be rated at 70W and BLDC fans shall be rated as per the actuals.
iii. Exhaust fans, fluorescent tubes, compact fluorescent tubes, HPMV lamps, HPSV lamps, CFL fittings etc. shall be rated according to their capacity. Control gear losses shall also be considered as applicable.
iv. 6A and 16A socket outlet points shall be rated at 100W and 1000W respectively, unless the actual values of loads are specified.
v. A.C. point shall be rated as 2 kW & Water heater point shall be rated as 3 kW.

Load more than 1 kW shall be controlled by suitably rated MCB / Isolator.

5.6 General Requirements:

5.6.1 The wiring for lighting circuits shall be done in looping system. The phase conductor shall be looped at switch box for sub-circuit. The neutral conductor for sub-circuit can be looped either from switch box or from light/fan/socket points. Twisted joints for looping are not acceptable.

5.6.2 No joints in wiring will be permitted anywhere, except in switch box or point outlets, where jointing of wires will be allowed with use of suitable connector.

5.6.3 In case of socket outlet, the controlling switch shall be connected on the live wire / phase wire.

5.6.4 Colour Coding of Wiring: Following colour coding shall be followed in wiring:

Wire	Colour
Phase	Red, Yellow, Blue. (Three phase wiring)
Live	Red (Single phase wiring)
Neutral	Black
Earth	Green

5.6.5 The size of conductor shall be used as follows:

Circuit	Phase & Neutral Wire Size	Earth wire Size
Lighting Circuit	1.5 sq. mm	1.5 sq. mm.
16 A Power Point Circuit	2.5 sq. mm.	1.5 sq. mm.
AC / Water Heater Circuit	4.0 sq. mm.	2.5 sq. mm.
Submain wiring	6.0 sq. mm.	4.0 sq. mm
	10.0 sq. mm.	6.0 sq. mm

5.6.6 Primary Point: In case of more than one light / fan being controlled by one switch, the wiring up to the termination point of the first light / fan including the switch shall be considered as a 'Primary' point.

5.6.7 Secondary Point: Loop wiring from termination point of first light / fan to second light / fan shall be considered as a "Secondary point".

Unless otherwise specified all the points are primary points.

5.7 Surface PVC Casing-N-Capping:

i. All casing-n-capping shall be made of good quality heavy gauge rigid Fire Resistant (FR) PVC, free from defects like deformation, unevenness, blisters, cavities etc. having colour & size as mentioned in schedule of quantities.

ii. The Casing Capping shall have a square or rectangular body.

iii. Casing should be equipped with rail on its surface on which clip-on partition (Capping) can be clipped.

iv. The casing shall be fixed using GI screws on wall fixed at an interval of 300 mm along horizontal run and along vertical run. In addition, where ever the direction of Casing changes additional fixing shall be provided for firm fixing.

v. The Capping shall be "CLIP-ON" type with double grooving & double locking arrangement & shall be clipped over the casing once the conductor wires are drawn in

vi. When capping is clipped onto the casing body, cover should completely overlap on the base (casing).

vii. The Casing Capping in straight runs should be in single piece as far as possible so as to avoid joints & shall be of 2 m or 3 m standard length for the ease of installation.

viii. At the bends Vertical / Horizontal section of PVC casing & capping shall be scarfed or cut diagonally at an angle of 45 degrees in a manner to complete matching at the bend & shall be smoothed down by filing to make the joints a very close fit as far as possible and without burrs.

ix. Trucking systems shall be so designed that when they are installed and fitted with insulated conductors and apparatus in normal use, parts are not accessible.

x. The bunching tags at the intervals of 600 mm shall be provided inside casing capping to avoid hanging of wires

xi. Shall be fire resistant & shall not ignited easily or if ignited, should extinguishes within 30 sec, after the removal of flame.

xii. Insulation resistance shall not be less than 100 Mega ohm

xiii. The cover should not detach from main part without use of any tool.

xiv. Testing shall be done as per IS-14927 (2001).

5.8 Number of Wires in Casing-N-Capping

The maximum number of wires that may be laid in PVC trunking for circuit wiring or point wiring is given below :-

Maximum number of PVC insulated 650 / 1100 Volt Grade Aluminium / Copper conductor cable conforming to IS: 694-1990

Nominal Cross sectional area	16 x 16 mm	25 x 12 mm	25 x 16 mm	38 x 16 mm	38 x 25 mm	38 x 38 mm
1.5	3	5	6	8	12	18
2.5	2	4	5	6	9	15
4	2	3	4	5	8	12
6		2	3	4	6	9
10		1	2	3	5	8
16			1	2	4	6
25				1	3	5
35					2	4
50					1	3
70					1	2

Note:

i. Dimensions shown above are outer dimensions of mini trunking.
ii. Size of mini trunking to be used as per S.O.Q.

5.9 HMS PVC CONDUITING:

5.9.1 General requirements

i. All non-metallic conduit pipes shall be rigid FRLS UV Stabilized PVC High Mechanical Strength conduits with ISI marking complying with IS 9537 (Part 3) and IS 3419 for rigid conduits and IS 9537 (Part 5) for flexible conduits. The interior of the conduits shall be free from obstructions.
ii. The conduits shall be circular in cross-section. The conduits shall be designated by their nominal outside diameter.
iii. No non-metallic conduit less than 20 mm in diameter shall be used.
iv. Rigid conduit accessories shall be normally of grip type.
v. Flexible conduit accessories shall be of threaded type.
vi. Bends, couplers etc. shall be solid type in recessed type of works, and may be solid or inspection type as required, in surface type of works. In long distance straight runs of conduit, inspection type couplers at reasonable intervals shall be provided.
vii. Conduit pipes including all bends, unions, tees, junction boxes etc. forming part of the conduit system shall be adequately supported.
viii. All accessories of non-metallic conduit like junction box, bend etc. shall be ISI marked & shall comply to BIS 3837: Accessories for Rigid Non-metallic Conduit.

5.9.2 Installation

A. Common Aspects for Both Recessed and Surface Conduit Works

i. The erection of conduits of each circuit shall be completed before the cables are drawn in.

ii. Conduit Joints: All joints shall be sealed/cemented with approved cement. Damaged conduit pipes/fittings shall not be used in the work. Cut ends of conduit pipes shall have

neither sharp edges nor any burrs left to avoid damage to the insulation of conductors while pulling them through such pipes.

B. Bends in Conduit

All bends in the system may be formed either by bending the pipes by an approved method of heating, or by inserting suitable accessories such as bends, elbows or similar fittings, or by fixing non-metallic inspection boxes, whichever is most suitable. Where necessary, solid type fittings shall be used.

Radius of bends in conduit pipes shall not be less than 7.5 cm. No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.

Care shall be taken while bending the pipes to ensure that the conduit pipe is not injured, and that the internal diameter is not effectively reduced.

C. Surface Conducting Work

i. Conduit pipes shall be fixed to wall / column / slab /beam with readymade PVC saddles & spacer, secured to suitable approved plugs with GI screws in an approved manner, at an interval of 450mm.

ii. Where the conduit pipes are to be laid along the trusses, steel joists etc. the same shall be secured by means of saddles or girder clips as required by the Engineer- in-charge. Where it is not possible to use these for fixing, suitable clamps with bolts and nuts shall be used.

iii. If the conduit pipes are liable to mechanical damage, they shall be adequately protected.

D. Fixing of Conduits in RCC Work

i. The conduit pipes shall be laid in position and fixed to the steel reinforcement bars by steel binding wires before the concrete is done.
ii. The conduit pipes shall be fixed firmly to the steel reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent tamping of the same.
iii. Fixing of standard bends or elbows shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with a long radius, which will permit easy drawing in of conductors.
iv. Location of inspection / junction boxes in RCC work should be identified by suitable means to avoid unnecessary chipping of the RCC slab subsequently to locate these boxes.

E. Recessed Conducting Work:

i. Before installing conduits, junction boxes and inspection boxes in the wall, a chase in the wall shall be neatly made and shall be of ample dimensions to permit the conduit & boxes to be fixed in the manner desired.
ii. Fixing Conduits in Chase: The conduit pipe shall be fixed by means of staples or by means of non-metallic saddles, not more than 60 cm apart or by any other approved means of fixing.
iii. The chase shall be closed neatly and shall be finished flush with the wall after erection of conduit system.
iv. All this work shall be completed before plastering of the wall & in Co-ordination with civil agency.

F. Laying above false ceiling:

Where conduit pipes are to be laid above false ceiling, conduit pipes shall not be clamped to false ceiling frame work and shall be suspended with suitable supports from the suffix of slab.

For conduit pipes to run along with wall, the conduit pipe shall be clamped to wall above false ceiling in uniform pattern with readymade PVC saddles & spacer at the intervals of 450mm.

G. Inspection Boxes

i. Suitable inspection boxes to the minimum requirement shall be provided to permit inspection and to facilitate replacement of wires, if necessary.
ii. These shall be mounted flush with the wall or ceiling concrete. Minimum 65 mm depth junction boxes shall be used in roof slabs and the depth of the boxes in other places shall be as per IS 2667:1988.
iii. Suitable ventilating holes shall be provided in the inspection box covers.
iv. Fixing Switch Boxes and Accessories

v. Switch boxes shall be mounted flush with the wall. All outlets such as switches, socket outlets etc. shall be flush mounting type, unless otherwise specified in the Additional Specifications m/ BOQ.

H. Fish Wire

To facilitate subsequent drawing of wires in the conduit, GI fish wire of min. 20 SWG or as required shall be provided along with the laying of the recessed conduit.

I. Bunching of Cables

Cables carrying Direct Current may, if desired, be bunched whatever their polarity, but cables carrying alternating current, if installed in metal conduit shall always be bunched so that the outgoing and return cables can be drawn into the same conduit.

Where the distribution is for single phase loads only, conductors for these phases shall be drawn in one conduit. In case of three phase loads, separate conduits shall be run from the distribution boards to the load, points, or outlets as the case may be.

J. Earthing Requirements

A protective (earth) conductor shall be drawn inside the conduit in all distribution circuits to provide for earthing of non-current carrying metallic parts of the installation. These shall be terminated on the earth terminal in the switch boxes, and/or earth terminal blocks at the DBs.

K. Non-metallic conduit shall not be used for the following applications:

i. In concealed/inaccessible places of combustible construction where ambient temperature exceeds 60 degrees C.
ii. In places where ambient temperature is less than 5 degrees C.
iii. For suspension of fluorescent fittings and other fixtures.
iv. In areas exposed to sunlight.

5.10 Wiring accessories:

- Wiring accessories consists of switch boxes, controlling switches, sockets, fan regulators, cover plate with frame, ceiling rose, Lamp holders etc.
- Controlling switches, sockets, fan regulators, cover plate & frame shall be modular type, made up of polycarbonate material & of white colour unless otherwise specified. The dimensions of switches, sockets, and fan regulators shall preferably be ISI marked.
- Angle holder/ceiling roses shall also be of polycarbonate body.

5.11 Switch boxes:

5.11.1 Surface switch box:

i. The Surface switch boxes shall be fabricated out of 16 SWG MS CRCA powder coated sheet duly welded at the edges suitable for accommodating the required number of switches & accessories as given in the BOQ.

xiii. The surface switch boxes shall be got manufactured by OEM of wiring accessories and the sample of the same shall be got approved by Department. Suitable knockout shall be provided at the top for entry of casing-capping.

xiv. All the MS switch boxes shall be provided with one no. of 3 mm dia. brass screw in tapped hole on side for Earthing. The head of the screw shall be outside the box with a nut provided inside box.

xv. All metallic boxes / switch boxes shall be earthed with 1.1 kV grade FRLS PVC insulated 2.5 sq.mm copper flexible wire.

5.11.2 Concealed switch box:

i. The Concealed switch boxes shall be Factory made metal sheet enclosure fabricated out of hot dip GI sheet suitable for accommodating the required number of switches & accessories as given in the BOQ.

xvi. The switch boxes shall be got manufactured by OEM of wiring accessories and the sample of the same shall be got approved by Department

xvii. Shall have Top, bottom, side and back wall knockout for conduit entry from any direction. Knockouts are such that it is Possible to break open them without any special tool.

xviii. Shall have Screw less finish and rounded corners

The mounting and location shall be as specified in the drawing. Unless and otherwise specified, the mounting height shall not be more than 1.4 meter above floor level.

5.11.3 Switches

The modular switch shall be having following features as mentioned below: -

S.No.	Descriptions	Dept.'s requirement
1.	Standard	IS 3854
2.	Voltage	240V AC
3.	Current	As per BOQ
4.	Material (Base & Rocker)	Polycarbonate
5.	Construction	Modular
6.	Installation	Snap fit with Modular Plates
7.	Terminals	Brass (Screw Type)
8.	Screws	Steel with zinc plating
9.	Rocker spring	Stainless steel
10.	Shall be	Flame Retardant
11.	IP degree of protection	IP20
12.	Tests	Marking, Mechanical Strength, Making & Breaking Capacity, Temperature rise, Insulation resistance, Electric Strength Test

5.11.4 Sockets

The modular Sockets shall be having following features as mentioned below: -

S.No.	**Descriptions**	**Dept.'s requirement**
1.	Standard	IS 1293 / IEC 60950
2.	Voltage	240V AC
3.	Current	As per BOQ
4.	Material (Top cover & Base)	Polycarbonate

5.	Construction	Modular with Shutters
6.	Installation	Snap fit with Modular Plates
7.	Terminals	Brass (Screw Type)
8.	Screws	Steel with zinc plating
9.	P-N-E Contact	Brass
10.	Shall be	Flame Retardant
11.	IP degree of protection	IP20
12.	Tests	Marking, Resistance to ageing, Insulation resistance, electric strength, Temperature-rise , Making and breaking capacity , Mechanical strength

5.11.5 Fan Regulator

The modular Regulator shall be having following features as mentioned below:

S.No.	Descriptions	Dept.'s requirement
1.	Standard	IS 11037
2.	Voltage	240V AC
3.	Operation	Knob Operated 5 Steps
4.	Material (Top cover, Base & Knob)	Polycarbonate
5.	Construction	Modular
6.	Installation	Snap fit with Modular Plates
7.	Terminals	Brass (Screw Type)
8.	Screws	Steel with zinc plating
9.	Shall be	Flame Retardant
10.	IP degree of protection	IP20
11.	Tests	Leakage current, High voltage, Insulation resistance, Earthing connection , Protection against electric shock, Moisture resistance, Performance, Mechanical endurance, Power losses

5.11.6 Cover Plate & Frame

The modular Plate & Frame shall be having following features as mentioned below: -

S.No.	Descriptions	Dept.'s requirement
1.	Cover Plate Material	Polycarbonate
2.	Inner Frame	Metallic (CRCA steel)
3.	Construction	Modular
4.	Installation	Snap fit for Cover Plate & Screwing with screws for Frame
5.	Screws	Steel with zinc plating
6.	Shall be	Flame Retardant
7.	IP degree of protection	IP20
8.	Tests	Fittment Test , Glow Wire Test , Impact Test

5.11.7 Lamp Holders

Lamp holders shall be batten, angle, pendant or bracket holder type as per BOQ having following features:

i. Unbreakable polycarbonate body
ii. Brass Ring for holding of bulb to avoid breakage / damage of bulb locking
iii. Brass contacts for high current capacity & Low contact point resistance
iv. Shall be ISI marked

5.11.8 Ceiling Rose
i. Ceiling Rose shall be 3 Plate ceiling rose.
ii. Shall be made of polycarbonate body
iii. Shall have brass terminals
iv. Shall be ISI marked

5.11.9 Door Bell
i. Doorbell shall be Electronic type Bul-Bul Bell with step down transformer
ii. Shall be of polycarbonate body and
iii. Alarm Range of atleast 10 meter
iv. Shall preferably be ISI marked.

5.11.10 Wires:

- Single core 1100 Volts FRLS grade PVC insulated multi-stranded flexible copper conductor wires shall be used for wiring, unless and otherwise specified.
- The size of the conductor shall be as specified in Bill of quantities but in no case, it shall be less than 1.5 sq. mm for lighting circuit and 2.5 sq. mm. for power circuit.

A. Specifications of wires shall be as mentioned in the below table:

S.No.	Descriptions	Dept.'s requirement
1	Type	Multistranded Copper Conductor, FR-LSH PVC Insulated, Unsheathed, Single Core Flexible Cable
2	Applicable Standard	As per IS 8130/2013, IS 694/2010 etc. with latest up to date amendments
3	Voltage Grade.	Up to & including 1100 Volts
4	**Conductor :**	
4.1	Material	Plain Annealed High Conductivity Multistranded Copper Conductor
4.2	Nominal cross-sectional area	As per BOQ
4.3	Flexibility clause	Class - 5 as per IS:8130
4.4	Dia. of each strand	Wire Size shall be suitably selected to meet the requirements of conductor Resistance as per relevant clause of IS : 8130
4.5	Shape of conductor	Flexible Circular
5	Insulation Material.	PVC Type-D with FR-LSH properties as per IS 5831/1984
6	Insulation Colour	Red, Yellow, Blue, Black, Green
7	**Physical Properties for Insulation**	as per IS 5831 : 1984
7.1	Min. Tensile Strength (N/mm^2)	10.0 N/mm^2
7.2	Min. Elongation at Break (%)	150%
8	**FR-LSH Properties for Insulation**	
8.1	Flammability Test	Burning period after removal of Flame shall not exceed 60 sec & unaffected portions from the lower edge of the top clamp shall be at least 50 mm.
8.2	Critical Oxygen Index @ 27°C	Minimum 29%
8.3	Temperature Index °C	The minimum measured value of temperature Index shall

S.No.	Descriptions	Dept.'s requirement
		be 250°C at which Oxygen Index is 21%
8.4	Halogen Acid Gas Evolution	The level of Halogen Acid Gas evolved shall not exceed 20% by weight.
8.5	Smoke Density Rating	Maximum 60%

B. Mandatory test for wires:

The Acceptance Test as mentioned in IS 694-2010 (Reaffirmed 2020) shall constitute the mandatory test for wires:

i. Annealing test (for copper)
ii. Conductor resistance test
iii. Test for thickness of insulation
iv. Tensile strength and elongation at break of insulation
v. Insulation resistance test
vi. High voltage test or spark test
vii. Flammability test
viii. Oxygen index test
ix. Test for temperature index
x. Test for halogen acid gas evaluation
xi. Test for smoke density rating

5.11.11 BLDC ceiling fans:

Specifications of Ceiling fans shall be as mentioned in the below table:

Sl.No.	Description	Dept.'s requirement	
1.		1200mm sweep	900mm sweep
2.	Colour	White	White
3.	Type of motor	BLDC motor run on 1-Ø, 230 V, 50 Hz, AC	BLDC motor run on 1-Ø, 230 V, 50 Hz, AC
4.	Certification	5-Star Rated BEE	5-Star Rated BEE
5.	Winding material	Super enameled copper wire	Super enameled copper wire
6.	Class of insulation (min.)	'E'	'E'
7.	Temperature rise over ambient temperature (max.)	75° C	75° C
8.	Power factor (minimum)	0.90 at 5th speed.	0.90 at 5th speed.
9.	Minimum air delivery at 230V (M3/min.)	230 CMM at 5th step of fan regulator	170 CMM at 5th step of fan regulator
10.	Rated speed	350 rpm +/-10% at 5th step of fan regulator.	460 rpm +/-10% at 5th step of fan regulator.
11.	THD (maximum)	10%	10%
12.	Service ratio (minimum)	8	5
13.	Max. leakage current (µA)	210	210
14.	Fan blades	Minimum 1.1mm thick powder coated aluminum blades	Minimum 1.1mm thick powder coated aluminum blades
15.	Type of down	ID-15 mm, OD 19 mm, MS split	ID-15 mm, OD 19 mm, MS

Sl.No.	Description	Dept.'s requirement	
	rod, size and material & length.	shackles clips, 300 mm for concealed fan hook and 260mm for surface fan hook.	split shackles clips, 300 mm for concealed fan hook and 260mm for surface fan hook.
16.	Additional safety	Fan shall be supplied with additional safety chain (i.e. 18swg GI wire) with locking arrangement, 2 nos. of suitable holes shall be provided on fan shaft for fixing safety chain & termination of earth wire.	Fan shall be supplied with additional safety chain (i.e. 18swg GI wire) with locking arrangement, 2 nos. of suitable holes shall be provided on fan shaft for fixing safety chain & termination of earth wire.
17.	Testing	Procedure as per IS 374	Procedure as per IS 374
18.	Guarantee	Fans shall be guaranteed for 03 years from the date of installation.	Fans shall be guaranteed for 03 years from the date of installation.

- All ceiling fans shall be wired to ceiling roses or to special connector boxes, and suspended from hooks or shackles, with insulators between hooks and suspension rods. There shall be no joint in the suspension rod.

- Interconnections between fan and fan point shall be made with 1.1 kV grade 3 C x 1.0 sq.mm FRLS sheathed PVC insulated multi stranded copper conductor flexible cable including termination with suitable tinned copper lugs etc.

- Routine test certificates as per IS shall be submitted and got cleared from EIC.

- Painting of serial numbers as instructed by Engineer in charge on ceiling fans with black colour paint / permanent marker.

- Canopies shall be provided at top & bottom of the suspension rod.

5.11.12 Concealed Fan Hook:

i. For concrete roofs, a 12 mm dia. Powder coated MS rod in the shape of 'U' with their vertical legs bent horizontally at the top at least 19 cm on either side, and bound to the top reinforcement of the roof shall be used
ii. In buildings with concrete roofs having a low ceiling height, where the fan clamp mentioned above cannot be used, or wherever specified, recessed type fan clamp inside metallic box shall be used.

5.11.13 Surface Fan Hook:

Fan hook shall be made of MS 'T' section of approx. size 65 x 60 x 5 mm & approx. 100 mm long, painted with two coats of synthetic enamel paint over one coat of red oxide paint including drilling holes in corners and in center of webs & shall be fixed by four nos. of anchor fastener of size min 8 mm x 50 mm. 'S' hook made up of 8 mm dia. (approx.) SS rod shall also be provided for suspension of ceiling fan via T-Hook.

6.0 SOLAR PV SYSTEM

6.1 General Requirements

These specifications related to the solar PV installation in the buildings. The specifications cover general requirements to the fulfilled. These general specifications are supplemented by the specific requirement for particular buildings separately attached.

These specifications are governed by the General, additional and special conditions of the contract attached hereto.

6.1.1 Departure from Specifications:

No deviations are allowed in the tender submitted. No addition/alternation should be made in the tender book. However, any deviation should be brought out separately during pre-bid meeting for clarification/confirmations from the dept. otherwise it will be presumed there are no deviation and offer is deemed to include the same.

6.1.2 Completion of Contract:

Any work, fittings, accessories or apparatus which may not have been specifically mentioned in the specification but which are necessary in the equipment for the efficient and satisfactory working of the plant system, should be deemed to be included in the contract and should be executed and proved by the contractor. All plant/system and apparatus should be complete in all respect with all required materials whether details in regards to these materials are mentioned in the specifications or not.

6.1.3 s

The tender drawings indicate only the general scheme of requirements. The exact positions of panels, inverters & DB's etc. should be approved by the Engineer-in-charge before the commencement of work. Wherever required, detailed drawings shall be prepared by the contractor and should be got approved by the Engineer-in-charge.

Where considered necessary assembly, sub-assembly and other detailed drawings of all the equipment installation should be submitted for approval. The manufacture of any equipment should commence only after the approval of the Engineer-in-charge in writing to the corresponding contract drawings.

i. Four sets of the finally approved drawings incorporating all the modifications proposed by the Engineer-in-charge should be submitted along with the completion certificate before final payment is released and installation accepted by the department.
ii. The modifications should not be made in a drawing already approved without prior consent of Engineer-in-charge. Approval of the contract's drawings will not relieve the contractor if any of his obligation to meet all the requirements of the contract.
iii. Four sets of fully informative drawings for general layout, foundation of the equipment.

6.1.4 Instrument Instruction Books:

The contractor should supply on completion of the contract, four copies of Full instructions for the working of all plant with illustrated literature and maintenance manual. Complete price lists of spare parts and tools with their catalogue code numbers.

6.1.5 Materials:

All materials to be used in installation shall be new and of best quality conforming to the relevant IS/IEC/BS specifications.

They must be the products of reliable manufacturers of many years standing. All like parts of materials shall be interchangeable. In case of equipment such as circuit breakers, switch fuses etc. as descriptive and illustrated detailed technical data and literature shall accompany the tender.

The name of manufacturers of various materials shall be furnished taking into consideration of approved makes of materials indicated in the tender.

Samples of materials, wherever required should be submitted and got approved by the Engineer-in-charge, before use in the installation. One set of such approved samples shall be deposited with the Engineer-in-charge.

All materials shall be rust-proof or rendered rust-proof by application of suitable covers and paints. The supply of all equipment's, switchgears etc. shall be complete with accessories, fittings and mountings as may be required for their proper performance.

6.1.6 Workmanship

Good workmanship and neat finish appearance are the prerequisite for complying with the clause of these specifications. With a view to ensure fine workmanship the tenderer shall employ licensed wiremen. With an experience of not less than 5 years in the type of work they are engaged. The work should be done under the supervision of competent qualified, experienced and proved electrical Engineer or licensed electrical supervisor shall be responsible for carrying out all works in accordance with the approved drawings, specifications and instructions of E.I.C. Bad workmanship will not be accepted and shall be rectified at contractor's own risk and cost to the satisfaction of the Engineer-in-charge.
Tenderer shall furnish the name of supervisors and their wireman who will be engaged in this work with details of their experience.

6.1.7 Insurance

The tenderer shall insure at his own cost all the materials during transit from his factory to site as well as during storage at site till the system is handed over to the users after duly complete as per W.O. and instruction E.I.C.

6.1.8 Finish

The finish of all the equipment's should be such that they can withstand the humid salty tropical weather condition at site.

6.1.9 Spares

The tenderer shall quote separately for spares recommended by manufacturers for 5 years of satisfactory operation. The detailed list of spare parts recommended for the equipment's supplied shall be submitted and tenderer should quote accordingly.

6.1.10 Tools:

All special tools required for dismantling and assembly of the equipment covered by the contract shall be supplied and included in the contract. A list of items that will be supplied by the contractor should be submitted along with the tender.

6.1.11 Testing

The electrical contractor shall be solely responsible for the testing and commissioning of these installations covered by this specification in compliance with the standard procedure in vogue and also to obtain permission of the competent bodies for installation executed by the contractor. Any modification which is demanded by the competent body shall have to be carried out within the scope of the contract and without additional expense to department.
All necessary instruments for testing installation as per regulations shall be provided by the contractor carrying out the installation work. All tests shall be carried out in the presence of the Engineer-in-charge or his authorized representative and his approval shall be obtained in writing for the test results. The contractor shall submit four copies of approved and signed test certificates before handing over the installation work.

Contractor should carry out the tests on different equipments as specified in the subsequent section with the conditions thereof, in order to enable the Engineer-in-charge to determine whether the plants and work comply with the specifications and test. The contractor should arrange his own testing equipment required for tests to be carried out at site on any of the equipment.

Engineer-in-charge reserves the right to himself of having at the contractors expense any inspection or test of a reasonable nature carried out in addition to those specified in the specifications for different equipment at the contractors or subcontractor's premises or at site to satisfy himself that the plant and materials comply with the requirements of contract. All equipment must be tested as per IS/BS/IEC specification and IEE regulation in presence of the Engineer-in-charge or his duly authorized representative.

During installation and commissioning necessary testing at different stages should be done as specified under "Testing and commissioning" indicated in the tender document in the presence of Engineer-in-charge.

6.1.12 Defect Liability period

i. After the completion of the installation and testing the contractor should issue a certificate at the time of handing over, the **installation shall be guaranteed for a period of 12 months from the date of taking over installations by the Department**. During the period of guarantee all defects in materials and equipments supplied by him or in workmanship, shall be rectified or replaced free of cost to the Department.

ii. If it becomes necessary for the contractor to replace or renew any defective part of the installation or plant/equipments for purpose of rectification under this clause, the provisions of this clause shall apply to the plant/installation so replaced or renewed until the execration of six months from the date of such replacement/renewal or until the end of above mentioned period twelve months whichever may be the later.

iii. The contractor should get a certificate in writing from Engineer-in-charge for taking over the installation and forward the same along with the final bill.

iv. Security Deposit shall be returned to contractor after completion of guarantee period.

6.2 Grid Tied Solar Photo Voltaic System:

6.2.1 Introduction

The Grid Interactive Roof Top Solar Photo Voltaic plant shall consist of three major components viz. the solar photovoltaic (SPV) modules, galvanized array mounting MS structure and the inverter or power conditioning unit(s). The array mounting shall hold the PV modules in required position and the DC electrical energy shall be converted to AC power by the inverter, which is connected to the utility power grid. The AC power output of the inverter shall be fed to the grid panel through metering panel and solar panel. The 415 V AC 3-ph output of the system shall be synchronized with the grid and the power shall be exported to the grid depending upon solar power generation and local consumption.

6.2.2 Applicable standards

i. IEC 61215 / IS 14286 - Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval
ii. IS 12762 (Part 1,2,3,9,10) : To measure I-V characteristics of crystalline silicon photovoltaic devices
iii. IEC 61730 Part 1 and 2 - PV module safety qualification
iv. IEC 61701- Salt mist corrosion testing of PV module
v. IEC 62109-1/2 - Safety of power converters for use in photovoltaic power System
vi. IS: 875 - For wind speed design of solar PV structure
vii. IEC 60068-2 (1,2,14,30): Environmental Testing of inverter
viii. IEC 61683: Efficiency Measurement of inverter
ix. IEC 62109-1, 2: Product Safety Standard of inverter
x. IEC 61727: Grid Connectivity Standard/ Utility Interface of inverter

xi. IEC 62116: Test Procedure for Islanding Prevention Measures for Utility Interconnected PV Inverters
xii. IEC 61000: Electromagnet Compatibility of inverter

6.2.3 Specification of Solar PV Modules

The Photovoltaic modules must be tested & approved by one of the IEC authorized test centers as per relevant and latest IEC standards.
Solar PV modules shall be High-performance high efficiency MONO PERC Modules. Detailed specifications of the solar PV modules are given below:

Type	Mono PERC with half-cut cell configuration
Efficiency	>20%
Module minimum rated power	540 Wp or more
Number of cells	144
Bypass diodes	3 numbers or more per module (Schottky type)
Glass	3.2 mm Low Iron and Tempered glass with ARC coating
Encapsulate	PID Free & UV Resistant
Degradation warranty	Panel output (Wp) capacity to be >=90% of design nominal power after 10 years and >=80% of design Nominal power after 25 years.
Module frame	Anodized Aluminum Alloy
Junction box	IP68 Split junction box with 3 bypass diodes
PID resistant	The crystalline silicon-based modules supplied should be of Potential Induced Degradation (PID) free modules and the test certificate from third party lab complying with the same shall be provided.
RF Identification tag for each solar module	Shall be laminated inside the module and must be able to withstand environmental conditions and last the Lifetime of the solar module.
Wind Speed	2400 Pa
Snow load	5400 Pa
Cable & Connector (Protection degree / Type)	IP68 rated / MC4 compatible

A suitable number of Solar PV modules shall be connected in a series string. A suitable number of series strings shall be connected in parallel to formulate a series-parallel array (if required). The PV strings and array shall be designed to match the inverter input specifications.

The module frame shall be Torsion and corrosion resistant anodized aluminium frame. All the offered solar PV modules shall be of single make.

Testing and inspection:

Following acceptance tests as per IEC 61215 / IS 14286 shall be carried out in the presence of Dept. representatives at the Manufacturer's works or any third-party lab approved by MNRE. Cost of testing shall be included in the cost of the item.

i. Visual inspection
ii. Flash (IV) Test
iii. Electro-Luminescence (EL) Test
iv. Insulation Resistance (IR) Dry
v. Wet Leakage Test
vi. HiPot Test

6.2.4 Solar PV Modules Mounting GI Structure

The PV modules shall be mounted on fully modular dead weight type of metallic structures having adequate strength and appropriate design, which can withstand the load of the modules and high wind velocities. The support structure shall be hot dip galvanized steel.

Detailed specifications for the mounting structure are given below:

Wind velocity withstanding Capacity	50 Meter / Second
Structure material	Hot dip galvanized steel with a galvanization thickness of 100 microns.
Bolts, nuts, spring washers etc.	Stainless steel of grade SS 304 (M6, M10 etc. with 2 set of washers)
Mounting arrangement for PV module	Using prefabricated fully modular hot dip galvanized MS frame work for holding the PV panels comprising of L brackets, Rafters, Perlin's, Vertical posts, Column Bracings, Rear Bracings, Block Tray Members, Base Plates etc.
Mounting arrangement for Dead weight	Prefabricated hot dip galvanized MS \Block Tray made up of L & C sections with suitable support plate welded at the base on each leg. Suitable 2 mm thick EPDM Sheet shall be provided below plate at each leg.
Installation	The structures shall be designed for simple mechanical on-site installation without any welding work. No grouting or tampering of waterproofing is allowed on the roof.
Minimum distance between roof edge and mounting structure	400 mm
Access for panel cleaning and Maintenance	All solar panels must be accessible from the top for cleaning and from the bottom for access to the module junction box.
Panel orientation	Preferably South facing.
Dead Weights for PV panels	M20 grade PCC blocks. PCC blocks shall be properly secured and placed on the frames.

i. The contractor shall prepare installation details of the solar PV modules and the support structures with lay-out drawings and array connection diagrams. The work shall be carried out as per the designs approved by the EIC.
ii. Each structure should have angle of inclination of 9 – 11 degrees (or as per the site condition) to maximize the insolation and also considering to withstand wind velocities.
iii. All structural designs including dead weight (PCC blocks) sizes shall be furnished by the successful bidder for evaluation and validation by EIC before fabrication during execution.

Inspection and testing:

All the GI fabrications shall be inspected at Galvanizer's works for

i. Visual inspection and bill of material at GI structure manufacturer works.
ii. Acceptance Tests for galvanizing material as per IS at manufacturer works as per I5 4759, IS 2629, IS 2633, IS 6745.
iii. Adhesion/Hammer test
iv. Knife test
v. Zinc coating thickness test
vi. Preece test-copper sulphate test
vii. Mass of zinc-stripping test.
viii. Supplier shall submit the chemical test report of the all Mild steel HR sheet materials.

6.2.5 Array junction box / DCDB

Array junction boxes shall be provided at Inverter locations to accommodate the following:

i. DC disconnector to disconnect the PV strings from the Inverter for maintenance purpose. (One for each string)
ii. 1000V, Imax 40kA Type 2 Surge Protection Devices for protection against surge currents and voltages. (One for each MPPT).
iii. 1000V DC String fuses (One for each string).

The junction boxes should be wall mountable dust, vermin & waterproof & made of Thermoplastic (polycarbonate) / ABS enclosures with transparent covers having IP 65 & IK 08 protection for long-term use in PV systems.

The junction boxes shall have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming & outgoing cables. Suitable markings shall be provided on the bus bar for easy identification & cable ferrules shall be fitted at the cable termination points for identification. (on AJB side as well as PV module side).

All fuses shall have DIN rail mountable fuse holders & shall have a voltage rating and current rating as required.

5% spare terminals (along with cable glands) rounded off to next higher integer shall be provided to connect the PV strings in future. All terminal blocks shall be rated for min 1000V and rated continuously to carry maximum expected current.

All internal wiring shall be carried out with 1100 V grade FRLS multi-stranded flexible copper wires. All internal wiring shall be securely supported, neatly arranged readily accessible and connected to component terminals and terminal blocks. Wire terminations shall be made with solder less crimping type tinned copper lugs which firmly grip the conductor and insulation.

6.2.6 Grid Tied String Inverter/Power Conditioning Unit (PCU):

The string inverter/power conditioning unit shall be provided to convert DC power produced by SPV modules into 3 phase, 4 wire AC power. The power conditioning unit/inverter shall be grid connected. Inverter output should be compatible with the grid voltage & frequency.

Typical technical features of the inverter shall be as follows:

i. The kVA rating of string inverter for each PV system shall be according to the technical design and suitable for solar PV system's wattage.

ii. Inverter shall have inbuilt MPPT (Maximum Power Point Tracking) control to extract maximum energy from solar array and produce AC power.

iii. The AC output voltage and frequency of the inverter must synchronize automatically to the exact AC voltage and frequency of the grid. Grid voltage shall be continuously monitored and in the event of voltage going below or above a preset value, the solar PV system shall be disconnected from the grid within the set time. Both over voltage and under voltage relays shall have adjustable voltage setting and time settings (0 to 5 seconds).

iv. Inverter shall be IGBT (Insulated Gate Bipolar Transistor) based with associated control and protection devices.

v. The continuous power rating of the individual inverter shall be equivalent to minimum 100% of peak power rating of each array or sub array connected to the inverter.

vi. Each individual inverter will have all necessary protections against disturbances in frequency, voltage and current of the grid due to internal or external faults, abnormal

temperatures and islanding. Its prime function will be to protect itself and solar array from any factors as well as avoid unintentional islanding.

vii. The PCU shall have anti-islanding protection as per IEC 62116 or equivalent standard. In the event of captive bus failure, the inverter automatically switches to off- within 20-50 milliseconds. The Solar system shall be able to synchronize with the captive bus immediately after the restoration of captive bus.

viii. Control and read out should be provided on the indicating panel which is the integral part to the inverter. Display should be simple and show all the relevant parameter relating to PCU operational data and fault condition on LCD or equivalent display. It shall include all important parameter i.e. DC input voltage, AC output voltage, AC output current, AC output power, frequency etc.

ix. Inverter shall have ground fault protection on DC side.

There shall be following modes of functioning in inverters:

i. Standby Mode

- The control system shall continuously monitor the output of the solar power plant until pre-set value of voltage, frequency is exceeded.

- Basic System Operation (Full Auto Mode)

- The system shall automatically "wake up" in the morning and begin to export power provided there is sufficient solar energy and the grid voltage and frequency is in range.

- Maximum Power Point Tracker (MPPT)

- MPPT control algorithm shall adjust the voltage of the SPV array to optimize solar energy fed into the grid.

ii. Sleep Mode

- Automatic – "sleep" mode shall be provided so that unnecessary losses are minimized at night. The power conditioner must also automatically re-enter standby mode when threshold of standby mode reached.

A. Specifications of Inverter are as follows:

- Maximum Input DC power: Similar to KWp of PV module system
- Maximum DC input voltage: 1000V
- Nominal Output Frequency: 50Hz
- Nominal Output voltage: 415 V (shall follow AC voltage and frequency of the grid)
- Nominal AC voltage tracking range: +20%, - 20%
- Nominal AC frequency tracking range: +5 Hz, -5 Hz
- Minimum number of MPPT per inverter: 2nos
- Power factor: 0.8 lagging to 0.8 leading
- Waveform: Pure Sine Wave
- Harmonics AC side total harmonic current distortion < 3%
- Efficiency >97% at full load and >90% at 20% load
- Losses: Maximum losses in sleep mode: 2W
- Maximum losses in stand-by mode: 10W
- Operation: Completely automatic including wake-up, synchronization (phase locking) and shut down.
- MPPT range must be suitable to individual array voltages.
- Enclosure IP rating: Minimum IP65 (except cooling section if applicable)

B. Protections:

- Surge Protection
- Ground Fault protection
- Over voltage
- Over current
- Over/Under grid frequency
- Over temperature
- Short circuit
- Lightening
- Anti-Islanding
- Manual intervention must be possible through an access code
- Emergency switch-off button

C. Indications through LED/LCD display

- Inverter ON
- Grid ON
- Inverter Under / Over Voltage
- Inverter Overload
- Inverter Over Temperature

D. Accurate displays on the front panel:

- DC input voltage
- DC current & AC voltage (all 3 phases and line)
- AC current (all 3 phases and line)
- Power factor
- Ambient temperature
- Instantaneous & cumulative array power
- Instantaneous & cumulative output power
- Communication interface: LAN port/RS485

The power conditioning units / inverters should comply with applicable IEC/ equivalent BIS standard for efficiency measurements and environmental tests as per standard codes IS/IEC 61683 and IEC 60068 2(6,21,27,30,75,78).

The MPPT units should qualify IEC standards. The enclosures should be IP 65 and as per IEC 62208 specifications.

The PCU/ inverters shall be tested from the MNRE approved test centres / NABL /BIS accredited testing- calibration laboratories. In case of imported power conditioning units, these should be approved by international test houses.

The inverter shall include adequate internal cooling arrangements for operation in a non-AC environment.

E. Inspection and testing:

Following acceptance tests as per IEC 62116, 61627,61683, IS 16169 shall be carried out in the presence of Dept. representatives at the Manufacturer's works or any third-party lab approved by MNRE. Cost of testing shall be included in the cost of the item.

i. Grid Interconnection Tests (Harmonic & DC injection, Protection against abnormal voltage and frequency)
ii. Active Power Control
iii. Fixed Power Factor
iv. Fixed Reactive Power
v. Efficiency Test
vi. Anti-Islanding Test
vii. Earth Fault and Insulation Resistance (IR) Testing

6.2.7 DC CABLES / WIRES

500V (DC) grade UV resistant, Halogen Free & Flame Retardant cable conforming to TUV 2 Pfg 1169/08.2007 / EN 50618:2015 with latest amendments as per specifications given below:

Size: 1C x 4 sq. mm for array cabling between solar modules and upto Array junction box (combiner box).

The suitable size DC copper cables shall be selected from Array junction box to Inverter depending on the no. of input DC connectors available in Inverter. Termination of all the DC cables is in the scope of item.

All connections should be properly terminated using MC4 connectors, sealed from outdoor and indoor elements. Relevant codes and operating manuals must be followed.

A. TECHNICAL SPECIFICATIONS:

Rated DC Voltage	500 V
No. of core	One
Core size	4 Sq. mm
Conductor material	Electrolytic Class-5 ATC multistranded copper
Insulation	Halogen Free & Flame Retardant XLPO (cross linked polyolefin)
Thickness of insulation	Min. 0.7 mm
Outer sheath	Halogen Free & Flame Retardant XLPO (cross linked polyolefin)
Thickness of outer sheath	Min. 0.8 mm
Max. Conductor temperature for continuous rated current	120°C
Max. Conductor temperature during short circuit	200°C
Max voltage withstands	6500 Volts AC or 15 KV DC for 5 min

B. TESTS:

The following tests shall be conducted on subject material for acceptance in presence of departmental engineer at manufacturer's works.

No.	Kind of test	Test conditions
1	Electrical tests	
1.1	Conductor Resistance	Measuring of conductor resistance acc. to EN 50395
1.2	High voltage test at complete cable	Dielectric test at complete cable with 6.5 kV AC or 15 kV DC for 5 mins.
1.3	Absence of faults	Dielectric test at complete cable with 10 kV AC (100% during production)
1.4	Surface resistance of sheath	Surface resistance > $10^9\Omega$
1.5	Insulation resistance at complete cable	Insulation resistance > $10^{14}\Omega$ (at 20°C) Insulation resistance > $10^{11}\Omega$ (at 90°C)

Remaining all the testing shall be as per the 2 pfg 1169/08.2007 standards.

6.3 Standalone / Hybrid Solar Photo Voltaic System

6.3.1 Introduction:

Similar to a traditional solar PV system that is connected to the grid, a hybrid solar PV plant still uses photovoltaic (PV) materials to collect and convert sunlight into energy. In a traditional

system, that electricity is routed to the grid, which allows the user to go without a battery while still being able to access electricity during overcast days or the night.

With a hybrid solar system, however, the electricity is routed to a hybrid inverter and battery. Once the battery is full, the excess is channeled through a smart meter to the grid's power lines. This allows the user to retain a portion of the electricity, which can help power the installations not only during overcast days or the night but also if there is an energy blackout / Grid Failure.

Most of the components of Hybrid solar PV system are similar to that of Grid tied system except inverter & a battery bank. A Hybrid system uses an Hybrid type of Solar Inverter which is a combination of Charge controller & Inverter in a same unit. Hybrid system also have a battery bank which is used for storage of energy.

6.3.2 Applicable standards

i. IEC 61215 / IS 14286 - Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval
ii. IS 12762 (Part 1,2,3,9,10) : To measure I-V characteristics of crystalline silicon photovoltaic devices
iii. IEC 61730 Part 1 and 2 - PV module safety qualification
iv. IEC 61701- Salt mist corrosion testing of PV module
v. IEC 62109-1/2 - Safety of power converters for use in photovoltaic power System
vi. IS: 875 - For wind speed design of solar PV structure
vii. IEC 60068-2 (1,2,14,30): Environmental Testing of inverter
viii. IEC 61683: Efficiency Measurement of inverter
ix. IEC 62109-1, 2: Product Safety Standard of inverter
x. IEC 61727: Grid Connectivity Standard/ Utility Interface of inverter
xi. IEC 62116: Test Procedure for Islanding Prevention Measures for Utility Interconnected PV Inverters
xii. IEC 61000: Electromagnet Compatibility of inverter

6.3.3 Specification of Solar PV Modules

The Photovoltaic modules must be tested & approved by one of the IEC authorized test centers as per relevant and latest IEC standards.

Solar PV modules shall be High-performance high efficiency MONO PERC Modules. Detailed specifications of the solar PV modules are given below:

Type	Mono PERC with half-cut cell configuration
Efficiency	>20%
Module minimum rated power	540 Wp or more
Number of cells	144
Bypass diodes	3 numbers or more per module (Schottky type)
Glass	3.2 mm Low Iron and Tempered glass with ARC coating
Encapsulate	PID Free & UV Resistant
Degradation warranty	Panel output (Wp) capacity to be >=90% of design nominal power after 10 years and >=80% of design Nominal power after 25 years.
Module frame	Anodized Aluminum Alloy
Junction box	IP68 Split junction box with 3 bypass diodes
PID resistant	The crystalline silicon-based modules supplied should be of Potential Induced Degradation (PID) free modules and the test certificate from third party lab complying with the same shall be provided.

RF Identification tag for each solar module	Shall be laminated inside the module and must be able to withstand environmental conditions and last the Lifetime of the solar module.
Wind Speed	2400 Pa
Snow load	5400 Pa
Cable & Connector (Protection degree / Type)	IP68 rated / MC4 compatible

A suitable number of Solar PV modules shall be connected in a series string. A suitable number of series strings shall be connected in parallel to formulate a series-parallel array (if required). The PV strings and array shall be designed to match the inverter input specifications.

The module frame shall be Torsion and corrosion resistant anodized aluminium frame. All the offered solar PV modules shall be of single make.

Testing and inspection:

Following acceptance tests as per IEC 61215 / IS 14286 shall be carried out in the presence of Dept. representatives at the Manufacturer's works or any third-party lab approved by MNRE. Cost of testing shall be included in the cost of the item.

i. Visual inspection
ii. Flash (IV) Test
iii. Electro-Luminescense (EL) Test
iv. Insulation Resistance (IR) Dry
v. Wet Leakage Test
vi. HiPot Test

6.3.4 Solar PV Modules Mounting GI Structure

The PV modules shall be mounted on fully modular dead weight type of metallic structures having adequate strength and appropriate design, which can withstand the load of the modules and high wind velocities. The support structure shall be hot dip galvanized steel.
Detailed specifications for the mounting structure are given below:

Wind velocity withstanding Capacity	50 Meter / Second
Structure material	Hot dip galvanized steel with a galvanization thickness of 100 microns.
Bolts, nuts, spring washers etc.	Stainless steel of grade SS 304 (M6, M10 etc. with 2 set of washers)
Mounting arrangement for PV module	Using prefabricated fully modular hot dip galvanized MS frame work for holding the PV panels comprising of L brackets, Rafters, Perlin's, Vertical posts, Column Bracings, Rear Bracings, Block Tray Members, Base Plates etc.
Mounting arrangement for Dead weight	Prefabricated hot dip galvanized MS \Block Tray made up of L & C sections with suitable support plate welded at the base on each leg. Suitable 2 mm thick EPDM Sheet shall be provided below plate at each leg.
Installation	The structures shall be designed for simple mechanical on-site installation without any welding work. No grouting or tampering of waterproofing is allowed on the roof.
Minimum distance between roof edge and mounting structure	400 mm
Access for panel cleaning and Maintenance	All solar panels must be accessible from the top for cleaning and from the bottom for access to the module junction box.

Panel orientation	Preferably South facing.
Dead Weights for PV panels	M20 grade PCC blocks. PCC blocks shall be properly secured and placed on the frames.

i. The contractor shall prepare installation details of the solar PV modules and the support structures with lay-out drawings and array connection diagrams. The work shall be carried out as per the designs approved by the EIC.
ii. Each structure should have angle of inclination of 9 – 11 degrees (or as per the site condition) to maximize the insolation and also considering to withstand wind velocities.
iii. All structural designs including dead weight (PCC blocks) sizes shall be furnished by the successful bidder for evaluation and validation by EIC before fabrication during execution.

Inspection and testing:

All the GI fabrications shall be inspected at Galvanizer's works for

i. Visual inspection and bill of material at GI structure manufacturer works.
ii. Acceptance Tests for galvanizing material as per IS at manufacturer works as per I5 4759, IS 2629, IS 2633, IS 6745.
iii. Adhesion/Hammer test
iv. Knife test
v. Zinc coating thickness test
vi. Preece test-copper sulphate test
vii. Mass of zinc-stripping test.
viii. Supplier shall submit the chemical test report of the all Mild steel HR sheet materials.

6.3.5 Array junction box / DCDB

Array junction boxes shall be provided at Inverter locations to accommodate the following:

i. DC disconnectors to disconnect the PV strings from the Inverter for maintenance purpose. (One for each string)
ii. 1000V, Imax 40kA Type 2 Surge Protection Devices for protection against surge currents and voltages. (One for each MPPT).
iii. 1000V DC String fuses (One for each string).

The junction boxes should be wall mountable dust, vermin & waterproof & made of Thermoplastic (polycarbonate) / ABS enclosures with transparent covers having IP 65 & IK 08 protection for long-term use in PV systems.

The junction boxes shall have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming & outgoing cables. Suitable markings shall be provided on the bus bar for easy identification & cable ferrules shall be fitted at the cable termination points for identification. (on AJB side as well as PV module side).

All fuses shall have DIN rail mountable fuse holders & shall have a voltage rating and current rating as required.

5% spare terminals (along with cable glands) rounded off to next higher integer shall be provided to connect the PV strings in future. All terminal blocks shall be rated for min 1000V and rated continuously to carry maximum expected current.

All internal wiring shall be carried out with 1100 V grade FRLS multi-stranded flexible copper wires. All internal wiring shall be securely supported, neatly arranged readily accessible and connected to component terminals and terminal blocks. Wire terminations shall be made with solder less crimping type tinned copper lugs which firmly grip the conductor and insulation.

6.3.6 Hybrid solar inverter cum charge controllers

Hybrid solar inverter shall be a multi-functional inverter that combines the functions and capabilities of both grid-tie and off-grid solar inverters. One side, it shall stores the electricity into the solar battery for crucial times and on the other side, it shall exports the excess or unconsumed electricity to the utility grid.

As day turns to night, the solar panel will cease to produce energy at which points solar inverter shall automatically fulfill the consumption of the installations from battery stored energy. In case, the consumption exceeds what the batteries are able to supply then it shall automatically switch over to the utility grid and continue to operate.

A. The PCU shall have two operating modes:

xix. **Stand-alone:** Solar Inverter operates from solar battery and produces AC output. It shall function as a stand-alone power plant feeding the connected loads when grid is not available.

xx. **Grid Interactive:** In the day time the first priority of the inverter shall be to charge the battery. Whenever battery reaches float charge, inverter shall be supplying the connected load in conjunction with the grid. Any excess solar power shall be exported into the grid. Whenever sufficient solar power is not available to run the load, the required power is shared from the grid.

B. Hybrid Inverter shall have the following features:

- In case inverter is not functioning, there shall be provision to bypass the load on to grid or DG. At any point there shall not be any back feeding to the DG.

- Battery based solar inverter cum charge controller shall be a single panel with Inbuilt high-efficiency MPPT charge controller. Charge controller shall be integral part of inverter (separate units of charge controller and inverter placed in a single enclosure is not acceptable). Charge controller is the front end of the solar inverter which will have the MPPT charger in order to charge the battery and shall be internally coupled with inverter section of the solar inverter.

- The charge controller shall be having the following functionalities:

i. Charge controller shall be capable of 3 step (float, boost and trickle) charging, depending on the state of charge of the battery. Inverter/charge controller shall utilize solar/grid power to charge the battery bank till battery reaches float with solar as priority for charging the battery.

xxi. Once the battery cells reach float, solar power generated shall be used to meet the connected site load. The provision for grid export is optional and shall be set point controllable if not required.

xxii. In general, the priority of supply to the load should be solar, grid and battery.

xxiii. Once the battery cell drops below the pre-determined voltage (say 1.1 Vpc), load should be disconnected from battery automatically. Solar/grid charging shall commence and continue till battery reaches float. After battery cells reaches float voltage, charging shall be adjusted in such a way to maintain the float voltage.

- Shall have LCD panel which can display various detailed information.

C. SPECIFICATION

INPUT	
Input Voltage Range	360 VAC to 450 VAC
Nominal Frequency	50 Hz (± 6%)
Input Fault Level	10 kA

Self Consumption	upto 4%
Grid / DG compatibility	Yes
SOLAR	
Charger Type	MPPT
Max PV Voltage (VOC)	Upto 1200V
MPPT Voltage Range	800-1100V
No. of MPPT Channel	3 / 2
Max I/P Amps per Channel (Amps)	Upto 125
Panel Reverse protection	Yes
Solar Charger Effieciency	upto 95%
BATTERY	
Nominal Battery Volatege (Vdc)	Upto 600V
Grid Charging Current	Selectable as 5A steps
Input Power Factor (Grid Charging)	Near to Unity
Battery Charging Volatege	Selectable from LCD Display
Type & No. of Cells	Lead Acid / VRLA / Ni-Cd / Lithium
OUTPUT	
Load Power Factor	0.8 lag
Output Voltage (Inverter Mode)	415V AC
Voltage Regulation	± 2%
Output Frequency (Free Running)	50 Hz ± 0.5%
Output Waveform	Pure Sine Wave
Peak Inveretr Efficiency	upto 90%
THD	<3%
Overload Capacity	125% for 60 Sec, 150% for 5 Sec
Changeover Time (Full Load)	20 msec
AC/DC Isolation	Inbuilt isolation transformer
Anti islanding function	Available
CONFIGURATION	
Modes Available	Hybrid / Grid Export / Standalone
Battery Buffer setting	Selectable 25%, 50%, 75%
GRID Feed Mode	Enable / Disable option
PHYSICAL	
Enclosure	IP20
Cooling	Forced Air
Protections:	Surge Protection Ground Fault protection Over voltage Over current Over/Under grid frequency Over temperature Short circuit Lightening Anti-Islanding Manual intervention must be possible through an access code Emergency switch-off button

Inspection **and testing:**

Following acceptance tests as per IEC 62116, 61627,61683, IS 16169 shall be carried out in the presence of Dept. representatives at the Manufacturer's works or any third-party lab approved by MNRE. Cost of testing shall be included in the cost of the item.

i. Grid Interconnection Tests (Harmonic & DC injection, Protection against abnormal voltage and frequency)
ii. Active Power Control
iii. Fixed Power Factor

iv. Fixed Reactive Power
v. Efficiency Test
vi. Anti-Islanding Test
vii. Earth Fault and Insulation Resistance (IR) Testing

6.3.7 DC CABLES / WIRES

- 500V (DC) grade UV resistant, Halogen Free & Flame Retardant cable conforming to TUV 2 Pfg 1169/08.2007 / EN 50618:2015 with latest amendments as per specifications given below:

- Size: 1C x 4 sq. mm for array cabling between solar modules and upto Array junction box (combiner box).

- The suitable size DC copper cables shall be selected from Array junction box to Inverter depending on the no. of input DC connectors available in Inverter. Termination of all the DC cables is in the scope of item.

- All connections should be properly terminated using MC4 connectors, sealed from outdoor and indoor elements. Relevant codes and operating manuals must be followed.

A. TECHNICAL SPECIFICATIONS:

•	Rated DC Voltage	500 V
•	No. of core	One
•	Core size	4 Sq. mm
•	Conductor material	Electrolytic Class-5 ATC multistranded copper
•	Insulation	Halogen Free & Flame Retardant XLPO (cross linked polyolefin)
•	Thickness of insulation	Min. 0.7 mm
•	Outer sheath	Halogen Free & Flame Retardant XLPO (cross linked polyolefin)
•	Thickness of outer sheath	Min. 0.8 mm
•	Max. Conductor temperature for continuous rated current	120°C
•	Max. Conductor temperature during short circuit	200°C
•	Max voltage withstands	6500 Volts AC or 15 KV DC for 5 min

B. TESTS:

The following tests shall be conducted on subject material for acceptance in presence of departmental engineer at manufacturer's works.

No.	Kind of test	Test conditions
1	Electrical tests	
1.1	Conductor Resistance	Measuring of conductor resistance acc. to EN 50395
1.2	High voltage test at complete cable	Dielectric test at complete cable with 6.5 kV AC or 15 kV DC for 5 mins.
1.3	Absence of faults	Dielectric test at complete cable with 10 kV AC (100% during production)
1.4	Surface resistance of sheath	Surface resistance > $10^{9}\Omega$
1.5	Insulation resistance at complete cable	Insulation resistance > $10^{14}\Omega$ (at 20°C) Insulation resistance > $10^{11}\Omega$ (at 90°C)

Remaining all the testing shall be as per the 2 pfg 1169/08.2007 standards

6.3.8 Battery Bank:

i. The batteries shall be solar photovoltaic batteries of flooded electrolyte low maintenance, lead Acid/ VRL batteries as specified in BOQ and as per the relevant BIS standards & MNRE specifications can be used.
ii. Storage batteries should conform IEC 61427 / IS 1652 / IS 13369 as per specifications.
iii. The batteries shall use 2V and battery capacity is to be designed at C/10 rate with end cell cut off voltage of 1.85 V per cell.
iv. Battery terminal shall be provided with covers.
v. Batteries shall be provided with micro porous vent plugs with floats. Charging instructions shall be provided along with the batteries.
vi. Suitable carrying handle shall be provided.
vii. A suitable battery rack with interconnections & end connector shall be provided to suitably house the batteries in the bank. The features and dimensions of the battery rack shall be provided along with the bid document.
viii. The batteries shall be suitable for recharging by means of solar modules via incremental / open circuit regulators.
ix. The design cycle life of batteries at 80%, 10% and 20% depth of discharge at 27 deg. C shall be mentioned.
x. The batteries shall be designed for operating in ambient temperature of site.
xi. The self-discharge of batteries shall be less than 3 % per month at 20 deg. C and less than 6% per month at 30 deg. C
xii. The charge efficiency shall be more than 90% up to 70% state of charge. The topping up frequency shall be 12 – 18 months.
xiii. The batteries shall consist of individual cells, which can be carried separately with ease while transporting.
xxiv. Offered batteries shall comply to the following:

- 10 % of DOD: 7200 cycles
- 50 % of DOD: 3000 cycles
- 80 % of DOD: 1200 cycles

xxv. The Battery Bank shall be designed to provide 1-day autonomy. Bidder to provide battery sizing details along with their offer. The distance between two batteries may be kept 6 inches & vice versa.

xxvi. The batteries should be of tubular plate lead acid & low maintenance type and shall have long service life. The cells should confirm IEC 61427 / IS 1652 / IS 13369 and as per specification given below shall be provided.

xxvii. Each battery bank will contain suitable wooden/MS power coated rack, hydrometer, thermometer, celltester and connecting leads etc. as specified in BOQ.

7.0 EARTHING

7.1 Scope:

The scope of work under this section covers the earthing of various panels, distribution boards and utilization equipment.

7.2 Standards:

The following standards and rules shall be applicable -

IS – 3043 (latest) : Codes of practice for earthing.

Indian Electricity Act 2003 and rules issued there under.

7.3 Plate Electrode Earth PIT:

Plate earth station shall be provided with heavy dipped tinned copper earth plate electrode 600 x 600 x 3mm in size at the depth of 2.5 m below ground level (bottom of Plate) confirming to IS 3043 complete with all required materials like coke / charcoal, salt, Brass nut bolts, washers, 19 mm dia GI pipe (B class), concrete chamber duly plastered, heavy duty (minimum 6 mm thick) M.S chequred plate cover associated materials like 40 x 40 x 5 mm angle iron frame work, hinged locking arrangements, complete with funnels, Copper test links (50 x 6 mm), two runs of 50 x 6mm copper strips for connecting copper plate including brazing as required & test link etc. including excavation of ground in all types of soils, refilling & removal of excess earth within a radius of 3000 m etc. all as required as per the drawing specifications & instructed by Engineer-in-charge.

The chamber cover & frame shall be got approved by Department & painted with two coats of red oxide & one coat of enamel paint.

7.4 Equipment Earthing:

Three phase motors and other three phase apparatus shall have two distinct earth connection of size equal to 50% of the connecting cables.

For 1HP motor and 1HP apparatus, the single earth connection shall be provided.

For all light fittings and fans, a single earth connection with 1.5 sq. mm. copper shall be provided.

7.5 Earth continuity conductor for metallic conduits:

Metalic conduit shall not be accepted as an earth continuity conductor. A separate copper earth continuity conductor of size of 50% of phase conductor or 14 SWG copper wire whichever is more shall be provided.

The earth continuity conductor shall be clamped to the conduit at one meter intervals using approved copper earth clamps. Binding wire is not accepted as a substitute for earth clamps.

7.6 Size of copper strips/wires for earthing of distribution panel/sub panels/DBs:

Sr. No.	Size of incomer cable	Size of copper or GI strip/wire
1.	a) 10 sq. mm / 4 core	2 Nos. of 8 SWG tinned copper (or) 2 Nos. of 4 SWG GI
	b) 16 sq. mm / 4 core	
	c) 25 sq. mm / 4 core	
	d) 35 sq. mm / 3 ½ core	
2.	a) 50 sq. mm / 3 ½ core	2 Nos. of 4 SWG tinned copper or equivalent G.I. wire
	b) 70 sq. mm / 3 ½ core	
	c) 95 sq. mm / 3 ½ core	
3.	a) 120 sq. mm / 3 ½ core	2 Nos. of 25 mm x 3 mm tinned copper (or) 2 Nos. of 25 mm x 6 mm GI or 50 mm x 3 mm GI
	b) 150 sq. mm / 3 ½ core	
	c) 185 sq. mm / 3 ½ core	
4.	a) 240 sq. mm / 3 ½ core	2 Nos. of 25 mm x 6 mm tinned copper or 50 mm x 6 mm GI
	b) 300 sq. mm / 3 ½ core	
	c) 400 sq. mm / 3 ½ core	
	d) 500 sq. mm / 3 ½ core	

7.7 Grounding EQUIPMENTS:

Ground wires shall either terminate on ground lugs provided on the equipment or shall be fastened to the foundation bolt and the frame of equipment.

All conduits shall be grounded with approved proper size of earthing wire/strips as requested.

Ground wires terminating at every equipment shall have certain flexibility in its connection to the equipment.

Suitable size of sleeves required in the wall, column etc. taking earth strips across them shall be provided by the contractor during the civil construction. After laying the earth strip, the sleeve shall be properly sealed.

7.8 Erection:

Hot dipped GI strip shall be fixed to wall / slab / column / beam with 2mm thick GI saddle and min, 4mm thick GI spacer

In ground at a depth of 750 mm below ground level including excavation in all type of soil with protective baked bricks, refilling and removal of excess earth within a radius of 3000 m, temporary reinstatement and back filling of trench, interconnection of earth strip / wire GI nut bolts & washers, painting with two coats of black bituminous compound for earth strip in ground and green colour enamel painting strip on surface etc. all as required & instructed by the Engineer-in-charge.

TERMINATION:

Where the diameter of the bolt at the joints exceeds one quarter of the width of the earth continuity, the connection shall be made with a wider piece sandwiched between two conductors.

7.9 Supply and Installation Of Earthing System:

All medium voltage equipment shall be earthed by two separate and distinct earth connection using tinned copper/GI earth wire/strip of specified gauge.

All metallic conduits run for lighting & receptacle system shall be provided with continuous earth wire of 14 SWG tinned copper run along the conduit and connected to all lighting/power receptacles of 6A and 16A. Three phase, 60 Amps receptacles and associated conduit run will be earthed by 2 nos of 8 SWG tinned copper conductors or equivalent G.I. Wires/strips.

Earthing conductors, tinned copper/G.I. Earthing clamp and all other accessories required for earthing the lighting and receptacle system, conduit accessories and equipment as per drawings and specifications shall be supplied and installed by the contractor. Earth wires shall be protected against mechanical damage and possibility of corrosion particularly at the point of connection to the earthing terminals of panels and fitting.

All joints shall be made on tinned surfaces in case of copper earth system jointing earth wire shall be done only at junction boxes and equipment earthing terminals. The jointing on earth wires shall be done with approved type of connection & no twisted joint will be allowed.

The whole metallic conduit system shall be electrically continuous throughout and shall be permanently and efficiently connected to earth. When earth wire runs along the conduit the earth wire shall be clamped to the conduits securely on either side of the joint to ensure electrical continuity in the conduit system.

All non-current carrying metal parts of panels, lighting fixtures, junction boxes etc. shall be efficiently connected to earth.

7.10 Gland Earthing:

Cable gland earthing shall be done with brass earthing tags of suitable thickness, connecting to nearest earthing point with suitable size of earth wire/strip using brass nuts & bolts & washers (in case of copper earthing system) & GI nuts and bolts and washers (in case of GI earthing system) all as directed by Engineer-in-charge.

7.11 Site Test:

The following earth resistance values shall be measured with an approved earth megger and recorded.

i. Each earthing station
ii. Earthing system as a whole
iii. Earth continuity conductors

7.12 Mode of measurement:

Providing an earthing station complete with excavation electrode watering pipe, soil treatment, chamber etc. shall be treated as one unit of measurement.

The following items of work shall be measured and paid at unit rate covering the cost of the earth wires/strips, clamps, labour etc :-

- Main equipment earthing grid and connection to earthing station.
- Connection to power panels, distribution boards etc.

The cost of earthing the following items shall become part of the cost of the item itself and no separate payment for earthing shall be made :-

- Light fittings -form part of installation of light fitting.
- Conduit / PVC casing & capping - should form part of the wiring of cabling.
- Cable glands earthing.

8.0 MAINTENANCE FREE EARTHING

8.1 Scope:

This document covers specifications of maintenance free earthing components to be used for following purposes: -

i. Safety Earthing for building.
ii. Earthing for Lightining protection of buildings.

8.2 Applicable Standards:

IS 3043	Code of practice for earthing.
ANSI/UL 467	Safety for Grounding & bonding equipment.
IEC 62561-2	Requirement for conductors and earth electrodes.
IEC 62561-7	Requirement for earthing enhancing compound .
IEC 60068-2-52	Salt Mist Test and Humid Sulphur Atmosphere Test.
ASTM G 59-97	Potentiodynamic polarization resistance methods.
CET/TS 14997	Leaching behaviours principles and methods.
RDSO/SPN/197	Specification for Code of Practice for Earthing & Bonding System for Signalling Equipments.
IEEE 80 : 2000	Substation Earthing.
BS 7430 : 1998	Code of practice for earthing.
GP-311	CBIP Manual on Earthing of AC system.

8.3 Components of Maintenance free Earthing System:

The components of Maintenance free earthing system are as follows:

i. Earth Electrode.
ii. Earth enhancement material.
iii. GI/ tinned Cu strip for connecting the earth electrode to earth strip.
iv. GI/ tinned Cu strips for interconnection of earth electrodes below ground.
v. Earth pit for housing GI / tinned Cu main equipotential bar for body earthing.
vi. Earth pit for housing GI main equipotential bar for earthing of lightning protection system.

All the material like copper bonded rod, ground enhancement material, connectors etc. should be sourced from reputed suppliers & of excellent quality conforming to technical specifications.

8.4 Earth Electrode:

i. The earth electrode shall be made of high tensile low carbon steel circular rods, molecularly bonded with copper on outer surface to meet the requirements of IEC 62561-2.
ii. The earth electrode shall be connected to GI/ tinned Cu strip by exothermic welding only.
iii. Marking: Manufacturer's name or trade name, length, diameter, UL catalogue number must be punched on every earth electrode.

8.5 Earth Enhancement material:

Earth enhancement material is a superior conductive material that improves earthing effectiveness, especially in areas of poor conductivity (rocky ground, areas of moisture variation, sandy soils etc.) it improves conductivity of the earth electrode and ground contact area. It shall be tested and confirm to the requirements of IEC 62561-7 having following characteristics:

i. Shall have high conductivity, improves earth's absorbing power and humidity retention capability.
ii. Shall be non-corrosive in nature.
iii. Shall be suitable for installation in dry form or in a slurry form.
iv. Shall not depend on the continuous presence of water to maintain conductivity.
v. Shall be permanent & maintenance free and in its "set form", maintains constant earth resistance with time.
vi. Shall be thermally stable between-10deg. C to + 60deg. C ambient temperatures.
vii. Shall not dissolve, decompose or leach out with time.
viii. Shall not require periodic charging treatment nor replacement and maintenance.
ix. Shall be suitable for soils of different resistivity.
x. Shall be ROHS compliant & not pollute the soil or local water table and meets environmental friendly requirements for landfill.
xi. Shall not be explosive.
xii. Shall not cause burns, irritation to eye, skin etc.
xiii. Marking : The Earth enhancement material shall be supplied in sealed, moisture proof bags. These bags shall be marked with Manufacturer's name or trade name, quantity etc.

8.6 Backfill material:

The excavated soil/ good agricultural soil is suitable as a backfill but should be sieved to remove any large stones and placed around the electrode taking care to ensure that is well compacted. Material like sand, salt, coke breeze, cinders and ash shall not be used because of it acidic and corrosive nature. The backfill material shall be non-corrosive & ROHS compliant.

8.7 Earth grid:

i. The earth electrodes, as per drawing, shall be installed and connected to each other below ground, at each location, forming an earth grid.

ii. These earth pits shall then be inter linked using GI / tinned Cu strip, as per drg, to form a loop using exothermic welding technique.
iii. The interconnecting-conductor shall be buried at depth not less than 500mm below the ground level. This interconnecting conductor shall also be covered with earth enhancing compound as per recommendations of manufacturer & design.
iv. All the GI strip shall have galvanizing thickness of min. 85µ.
v. The earth grid shall be connected to a GI / tinned Cu main equipotential bar. The GI main equipotential bar shall be housed in concrete pit below ground as per instructions of EIC & site condition and all the earth strips from electrical equipment etc. shall be terminated on such GI/ tinned Cu main equipotential bar.
vi. All the interconnections will be done by exothermic welding except the terminations of earth strips from electrical equipment on GI main equipotential bar, which shall be with SS nut bolt/ clamp connection.
vii. The earthing grid for lightning protection shall be provided in similar manner & shall be separate from the safety earthing grid.
viii. The earth grid for lightning protection system shall be connected to a separate GI main equipotential bar. The GI main equipotential bar shall be housed in concrete pit below ground as per site condition and all the lightning down conductors shall be terminated on such GI main equipotential bar.
ix. The grids for safety earthing & lightning of respective buildings shall be interconnected by connecting spark gap arrestor between main equipotential earth bars of both safety earthing & lightning protection system.

8.8 Earth pit (Inspection chamber):

i. Each earth grid shall have one no. earth pit housing GI / tinned Cu main equipotential bar, as indicated above, for purpose of measuring earth grid resistance.
ii. The earth pit shall be concrete (1:2:4) chamber of size 600 X 600 X 600mm (inside dimension) with MS chequered plate hinged cover of min 10 mm thickness mounted on 40 x 40 x 5mm thick angle iron frame.
iii. The marking plate /pit marking space should be present on the cover.
iv. The date of testing and earth resistance value shall be written on the cover with black base with yellow paint.

8.9 Measurement of earth resistance :

i. The earth resistance shall be measured at the GI/ tinned Cu main equipotential bar with all the earth pits interconnected, using Fall of Potential method as per IEEE 80, BS 7430 & IS 3043.
ii. The digital earth tester for measurement of grid resistance shall be arranged by contractor & shall be of reputed make. The digital earth tester shall be calibrated & have facility of variable voltage & variable frequency for earth resistance measurement.
iii. The earth resistance value of each isolated safety earthing grids for buildings shall be less than 5Ω.
iv. The earth resistance value of each isolated lightning protection system shall be less than 10Ω.
v. The earth resistance value of earth pit for substation equipment earthing shall be less than 1Ω.

8.10 Testing of Maintenance free Earthing Components:

i. The manufacturers type test certificates, UL certification in respect to earth rods, Ground enhancement materials & exothermic welding connections shall be provided with delivery of materials.

ii. The following routine & acceptance tests as per IEC 62561, UL 467 etc. shall be conducted at manufacturers' premises or in Govt. approved NABL test labs in the presence of departments representatives. The following shall comprise acceptance & routine tests.

iii. Acceptance tests:

Sr. No.	Test
a)	Visual inspection
b)	Adherence of coating test
c)	Bending test
d)	Tensile strength test
e)	Resistivity test (on earth enhancement compound)

iv. Routine tests:

Sr. No.	Test
a)	Visual inspection
b)	Dimensional Check on earth electrode

xxviii. Sample plan

The following sampling plan for earth electrode shall be adopted for acceptance tests:

Lot size	Visual inspection / Dimension	Adherence to coating (457mm each)	Bend test (200mm each)	Tensile strength (200mm each)
2-8	2	2	2	2
9-15	3	2	2	2
16-25	5	4	4	2
26-50	8	4	4	2
51-100	13	4	4	2
101-150	20	4	4	2
151-200	32	4	4	2

xxix. For resistivity test min. two samples shall be selected.

xxx.If any of the sample fails during acceptance test the complete lot will be rejected.

9.0 INDOOR LED LUMINAIRES

9.1 GENERAL REQUIREMENTS

9.1.1 Luminaires:

The luminaire shall be designed and tested for general lighting application as per relevant standards.

9.1.2 Housing of the luminaire:

The housing construction of luminaire shall meet safety requirements as per IS 10322. The luminaire housing shall have minimum IP 20, IK 02 and shall be preferably made up of Al pressure die cast and powder coated. Control gear compartment shall be integral part/ independent of luminaire.

In case of non-metallic luminaire housing with above referred IP & IK, the material used shall be halogen free and fire retardant conforming to UL 94 V.0.
LEDs should be provided with secondary lens optics to get optimum optical performance.

9.1.3 Lumen maintenance and failure fraction:

The luminaire shall be designed for rating of 50000 hrs(min) and failure fraction of 10%(max) or as per values indicated in the guaranteed technical particulars.

9.1.4 Thermal management of LED luminaire:

Luminaire shall be designed for proper thermal management of LEDs. LED die temperature is affected by PCB thermal resistance and LED spacing on the board. Designed luminaire shall be such that the LED die temperature does not exceed the maximum Junction Temperature (Tj).Drive current should be determined for the surrounding ambient temperature (Ta) to dissipate the heat from the product.

9.1.5 Optics:

The luminaire optics shall be designed such that the lumen output shall be uniform and glare free.

9.1.6 LED driver:

The LED driver shall be designed for operating voltage range specified below and shall have built in voltage surge protection, Short Circuit, & Over Voltage protections.

9.1.7 TECHNICAL REQUIREMENTS OF LUMINAIRES:

Sr. No.	Parameter	Range
1.	Minimum system lumen output	As per BOQ
2.	Luminaire Efficacy	>100 lumen/watts or as specified in BOQ
3.	Correlated Current Temperature (CCT)	As per BOQ
4.	Colour Rendering Index (CRI)	>80
5.	Lumen maintenance	L70 @ 50,000 hrs
6.	Diffuser	Shall be UV resistant
7.	Range of Operating Voltage	150-270 V AC
8.	Rated Frequency	50 Hz +/- 3%
9.	Total Harmonic Distortion	< =10%
10.	Power Factor	>0.90
11.	Input Surge Protection	>2.5 KV
12.	Type of Driver	Constant Current
13.	Housing material	Die-cast Al/ CRCA
14.	IP & IK	20 & 02 / as specified in BOQ

9.1.8 PHOTOBIOLOGICAL SAFETY REQUIREMENTS:

For photo biological safety requirements, the luminaries shall comply with IS 16108.

9.1.9 TESTING:

The following tests shall be conducted on LED luminaries as per IS 16107 & sampling shall be as per IS 10322 (Part-5) from any NABL accredited Lab-

i. Marking
ii. Total input power
iii. Luminaire efficacy (lm/W)
iv. Colour rendering index (CRI) – only initial values to be measured
v. Correlated colour temperature (K) – only initial values to be measured
vi. Chromaticity tolerance – only initial values to be measured
vii. Power factor
viii. Luminous flux
ix. Luminous intensity distribution

9.1.10 MARKING:

The Luminaire shall be marked with product information as per IS 16107 / IS 10322.

9.1.11 WARRANTY:

Luminaire shall have **three years,** onsite replacement warranty from the supply date including Driver / Control Gear, LED, all accessories etc.

9.2 TECHNICAL DATA SHEET (TDS) :

The technical data sheets of the offered luminaires, complying with tender technical specifications, shall be submitted along with technical bid for evaluation.

10.0 OUTDOOR LED LUMINAIRES

10.1 GENERAL REQUIREMENTS:

10.1.1 Luminaires:

The luminaire shall be designed and tested for general lighting application as per relevant standards.

10.1.2 Housing of the luminaire:

The housing construction of luminaire shall meet safety requirements as per IS 10322.The luminaire housing shall have following minimum features:

i. Extruded aluminum heat sink, designed to act as efficient heat dissipater important for LED luminaires.

ii. Pressure die cast aluminum cover on both sides for holding of extruded aluminum heat sink.

iii. Luminaire provided with heat resistant UV stabilized polycarbonate/ toughened glass diffuser.

iv. Control gear compartment is an integral part of luminaire. There shall be separate compartment for control gear and LED modules.

v. LEDs are provided with secondary lens optics to get optimum optical performance.

vi. The driver used is specially designed to have sure voltage, open/short circuit protections.

vii. Luminaire is provided with a mounting bracket fixed on pressure die-cast aluminum covers for aiming adjustment.

viii. The luminaire housing shall have minimum IP 66, IK 07 and shall be preferably made up of die cast aluminum.

10.1.3 Lumen maintenance and failure fraction:

The luminaire shall be designed for L70 of 50000hrs (min) or as specified and failure fraction of 10% (max).

10.1.4 Thermal management of LED luminaire:

Luminaire shall be designed for proper thermal management of LEDs. LED die temperature is affected by PCB thermal resistance and LED spacing on the board. Designed luminaire shall be such that the LED die temperature does not exceed the maximum Junction Temperature

(Tj). Drive current should be determined for the surrounding ambient temperature (Ta) to dissipate the heat from the product.

10.1.5 Optics:

The luminaire optics shall be designed such that the lumen output shall be uniform and glare free.

10.1.6 LED driver:

The LED driver shall be of silicon potted & designed for operating voltage range specified below and shall have built in voltage surge protection, short Circuit, & Over Voltage protections.

10.2 TECHNICAL REQUIREMENTS OF LUMINAIRES:

10.2.1 ELECTRICAL REQUIREMENTS:

SL. NO	PARAMETER	RANGE
1.	Range of Operating Voltage	140 – 270 V AC
2.	Rated Frequency	50 Hz +/- 3%
3.	Total Harmonic Distortion	< 10% or as specified
4.	High Voltage Protection	HV cut off @ 325VAC+/- 15VAC
5.	Short Circuit Protection	Yes
6.	Open Load Protection	Yes
7.	Reverse Polarity Protection	Yes
8.	Driver Isolation	Yes
9.	Power Factor	≥0.90
10.	Input Surge Protection	≥4 KV or as specified
11.	Type of Driver	Constant Current

10.2.2 OPTICAL REQUIREMENTS:

SL. NO	PARAMETER	VALUES
1.	Luminaire Efficacy	As per Schedule of quantities
2.	Correlated Current Temperature (CCT)	As per Schedule of quantities
3.	Colour Rendering Index (CRI)	≥70
4.	LED Chip	Shall be LM 80 Certified
5.	Diffuser	Shall be UV resistant PC/ toughened glass

10.2.3 MECHANICAL REQUIREMENTS:

SL. NO	PARAMETER	VALUES
1.	Frame/Housing	Pressure die-cast Aluminium housing
2.	Heat Sink	Highly efficient extruded aluminium heat sink
3.	IP Grade	As per Schedule of quantities
4.	Impact resistance	As per Schedule of quantities

10.2.4 PHOTOBIOLOGICAL SAFETY REQUIREMENTS:

For photo biological safety requirements, the luminaries shall comply with IS 16108.

10.3 TESTING:

The following tests shall be conducted on LED luminaries as per IS 16107 & sampling shall be as per IS 10322 (Part-5) from any NABL accredited Lab-

i. Marking
ii. Total input power
iii. Luminaire efficacy (lm/W)
iv. Colour rendering index (CRI) – only initial values to be measured
v. Correlated color temperature (K) – only initial values to be measured
vi. Chromaticity tolerance – only initial values to be measured
vii. Power factor
viii. Luminous flux
ix. Luminous intensity distribution

10.3.1 MARKING:

The Luminaire shall be marked with product information as per IS 16107 / IS 10322.

10.3.2 WARRANTY:

Luminaire shall have 05 years, onsite replacement warranty from the supply date including Driver / Control Gear, LED, all accessories etc.

10.3.3 TECHNICAL DATA SHEET (TDS) :

The technical data sheets of the offered luminaires, complying with tender technical specifications, shall be submitted along with technical bid for evaluation.

11.0 HT CABLES (33KV(E) &11 KV(E))

11.1 SCOPE:

This specification is intended for the design, manufacture, testing, inspection, performance guarantee tests and delivery to site, installation and commissioning of HT power cables. The bidder shall furnish all the guaranteed technical particulars as listed in the specification.

This specification shall be read in conjunction with **Bill of Quantities (BOQ)**.

11.2 STANDARDS AND CODES:

Unless otherwise specifically mentioned in the document, the design, manufacture, testing and performance of all cables shall conform with latest edition of the following standards & codes:

IS : 7098 (Part-II)	:	Cross linked polyethylene insulated PVC sheathed cable for working voltage from 3.3 KV upto and including 33 KV cables.
IS : 3961 (Part-II)	:	Recommended current ratings for cables.
IS : 3975	:	Mild steel wires, strips and tapes for armouring of cables
IS : 4905	:	Methods for random sampling
IS : 5831	:	PVC insulation and sheath of electrical cables.
IS : 8130	:	Conductors for insulated electrical cables and flexible cords.
IS : 10418	:	Specification for drums for electric cables.
IS : 10810	:	Method of tests for cables.
ASTM-D-2843	:	Standard test method for density of smoke from the burning or decomposition of plastics.
ASTM-D-2863	:	Standard method for measuring the minimum oxygen concentration to support E3 candle like construction plastics.
IEC-754 (Part-I)	:	Test on gases evolved during combustion of

electric cables.

SS:424-1475 : Flammability testing of cables.

11.3 TECHNICAL SPECIFICATION:

This specification establishes the requirement of design, manufacture, testing at works and delivery to site and installation, testing at site, commissioning of HT cables

Technical Parameters for cables:

i.	Power system details	:	11/33 kV(E), 3Phase, 3wire, effectively earthed
ii.	Frequency	:	50 Hz
iii.	No.of core	:	Three
iv.	Core size	:	As per BOQ
v.	Core identification	:	By insulation colour
vi	Conductor	:	Stranded circular core Aluminium conductor
vii.	Conductor Screening	:	Extruded Semiconductor compound
viii.	Insulation	:	Extruded Cross Linked Polyethylene (XLPE) material.
ix	Insulation Screening Non metallic insulation shiel a) Core Shielding material	: :	Free strippable semi- conducting compound Copper Tape.
x.	Inner sheath	:	Extruded FRLS PVC type ST-2.
xi	Filler material	:	If used, shall be compatible with other materials of cable Construction.
xii	Armouring	:	Single layer galvanised strip armoured.
xiii	Overall serving	:	Anti rodent and anti termite extruded black FRLS PVC type ST-2
xiv	Manufacturing process for cross linking insulation	:	Dry curing (Gas curing).
xv	Max. conductor temperature for continuous rated current	:	90^0 C
xvi	Max. conductor temperature during short circuit when cable already attained temp. specified at xv. above.	:	250^0 C
xvii	Embossments on cable	:	Cable shall be embossed on the outer sheath at every 1 m. length sequential marking for type of the cable, the metered length of cable, make and year of manufacturing.

11.4 INSTALLATION OF HT CABLES IN GROUND:

In ground HT cables shall be laid upto 1200 mm depth in all type of soil/concrete, road cutting/ footpath cutting including excavation, sand bedding, laying of backed bricks on side & top of individual cable, temporary reinstatement, sand cushioning all around, backfilling, leveling, dewatering, consolidation, disposal of excess earth within the radius of 500 m as per specified in BOQ and making good to the original finish etc. providing brass cable number tag including supply of bricks, sand, cable tags etc. complete as per instructions of EIC.

11.5 TESTS:

11.5.1 Shop Tests:

The cables shall be subjected to shop tests & witnessed by department engineer in accordance with relevant standards to prove the design and general qualities of the cables as below:
Routine tests on each drum of cables.

Acceptance tests on drums chosen at random for acceptance of the lot.
Type tests Certificates shall be submitted for particular size & design of cable.

11.5.2 Site Tests:

The cables after installation at site shall be subjected to HV test & Megger test as per instruction of EIC.

Hi-pot testing & commissioning of joints shall be carried out at site.

12.0 LT POWER, CONTROL CABLES

12.1 SCOPE:

This specification establishes the requirements of design, manufacture, testing at manufacturer's works and delivery to site and installation, testing at site & commissioning of 1.1 KV grade LT PVC/XLPE insulated with extruded PVC inner sheath outer sheath made of FRLS PVC compound, galvanized round wire/flat strip armoured Aluminium/copper conductor cables.

12.2 STANDARDS AND CODES:

Unless otherwise specifically mentioned in the document, the design, manufacture, testing and performance of all cables shall conform with latest edition of the following standards & codes:

IS: 7098 (Part-I)	:	Cross linked polyethylene insulated PVC sheathed cable for working voltage and including 1100 Volts.
IS: 1554 (Part-I)	:	PVC insulated (heavy duty) electric cables for working voltage upto and including 1100V.
IS: 3961 (Part-II)	:	Recommended current ratings for cables.
IS: 3975	:	Mild steel wires, strips and tapes for armouring of cables
IS: 4905	:	Methods for random sampling
IS: 5831	:	PVC insulation and sheath of electrical cables.
IS: 8130	:	Conductors for insulated electrical cables and flexible cords.
IS: 10418	:	Specification for drums for electric cables.
IS: 10810	:	Method of tests for cables.
ASTM-D-2843	:	Standard test method for density of smoke from the burning or decomposition of plastics.
ASTM-D-2863	:	Standard method for measuring the minimum oxygen concentration to support E3 candle like construction plastics.
IEC-754 (Part-I)	:	Test on gases evolved during combustion of electric cables.
SS:424-1475	:	Flammability testing of cables.

12.3 TECHNICAL PARAMETERS:

i)	Power system details	:	415 V +/-10%, 3 phase, 4 wire solidly earthed.
ii)	Frequency	:	50 Hz.
iii)	Size of cable, conductor & quantity	:	As per S.O.Q.
iv)	Core identification	:	Colour scheme as per IS 1554 (part I) /88 or latest
v)	Conductor	:	Stranded circular/sector shape core Aluminium/Copper conductor
vi)	Rated voltage	:	1100 Volts
vii)	Insulation	:	XLPE
viii)	Maximum conductor temperature at rated current.	:	90 degree C
ix)	Maximum conductor temperature during short circuit under hot condition	:	250 degree C
x)	Inner sheath	:	Extruded PVC inner sheath
xi)	Filler material	:	If used, shall be compatible with other materials of cable construction
xii)	Armouring	:	Single layer galvanized steel round wire/ flat strip armoured.
xiii)	Overall serving (outer sheath)	:	Anti rodent and anti-termite extruded black FRLS grade PVC sheath (Type ST-2)
xiv)	Embossing on the cable	:	Cable shall be embossed / printed on the outer sheath at every 1 m. length as under :1.1 kV, PVCA/XLPE, conductor material, No. of core and size of cable, sequential marking for the metered length of cable, make and year of manufacturing

12.4 INSTALLATION OF LT CABLES IN GROUND:

Installation of 1.1 KV grade, copper/Aluminium conductor PVCA/XLPE cables shall be laid at a depth of 900mm below ground level including excavation in all type of soil/concrete, road cutting/footpath cutting, temporary reinstatement, back filling, levelling, dewatering, consolidation, removal of excess earth within the radius of 500 m, sand bedding, cables covered on top & sides by baked bricks conforming to IS: 1077, sand cushioning all around, making good to the original finish, providing brass cable number tag including supply of bricks, sand, cable tags etc. complete as per instructions of EIC.

12.5 INSTALLATION OF LT CABLES ON MS SUPPORT/TRENCHES WALL/SLAB/BEAM ETC.:

Installation of 1.1 KV grade, copper/Aluminium conductor XLPE cables on MS. Support/trenches/sleeves/wall/Slab/ beam/prefabricated Trays in cable trench shall be as per IS 1255. All necessary accessories for installation of cables such as G.I. saddle / clamps/supports, screw, nuts and bolts etc.is included in the scope of work.

12.6 TESTS:

12.6.1 Shop Tests:

The cables shall be subjected to shop tests & witnessed by department engineer in accordance with relevant standards to prove the design and general qualities of the cables as below:

i. Routine tests on each drum of cables.
ii. Acceptance tests on drums chosen at random for acceptance of the lot.
iii. Type tests Certificates shall be submitted for particular size & design of cable.

12.6.2 Site Tests:

The cables after installation at site shall be subjected to IR test as per instruction of EIC.

13.0 CABLE TRAY

The cable tray shall be supplied in convenient lengths and assembled at site to the desired lengths along with all required accessories and supports from same manufacturer. Cable tray systems shall be so designed and so constructed that in normal use, when installed according to the manufacturer's or responsible vendor's instructions, they ensure reliable support to the cables contained therein. They shall not impose any unreasonable hazard to the user or cables. Type test certificate for each size and its accessories are to be provided in compliance as per IEC 61537. This type test certificates should be provided from NABL accredited third party labs only.

The maximum permissible uniformly distributed load for various sizes cables trays and for different supported span shall be considered as per CPWD specifications. Load for future cables and empty spaces to be also considered while designing supports. However minimum two supports for each standard length shall be provided. A third-party load test certificate conducted at reputed labs are to be provided in compliance of loading capacity each typical size as specified in BOQ.

The width of the cables tray shall be chosen so as to accommodate all the cables in one tier, plus min. 30% additional width for future expansion. The overall width of one cable tray shall be limited to 900mm.

The cable tray shall be suspended from the ceiling slab or side walls or as required with the help of required supports. Supports are to be made of minimum 10 mm dia continuous threaded GI round or as per requirement as instructed by engineer in charge. In case more than one tray are required to be installed in multi-tier formation, supports and clamps are required to be provided as per actual load calculation as required. Round suspenders shall be threaded and bolted to the cable trays or to independent support angle 50 mm x 50 mm x 5mm at the bottom and as specified. These shall be grouted to the ceiling slab including required anchor fasteners at the other end through an effective means, as approved by the Engineer in charge, to take the weight of the cable tray with the cables. Load for future cables and empty spaces to be also accounted while designing supports.

Each system component shall be durably and legibly marked with the manufacturer's or responsible vendor's name or trademark or identification mark and a product identification mark which may be, for example, a catalogue number, a symbol, or the like as suggested by engineer in charge.

The manufacturer shall provide in his literature all information necessary for the proper and safe installation and use of the cable tray system, The SWL and impact resistance is valid for the whole temperature classification declared. The information shall include instructions for the assembly and installation of system components and for the precautions required to avoid excessive transverse deflection, which could cause damage to the cables. The appropriate material specification and environmental conditions, chemical environments, or aggressive agents for which the product is suitable for.

Safe Working Load (SWL): Cable tray systems are suitably designed to carry the maximum permissible uniformly distributed load in Kgs. per running meter for different unsupported free spans are as per CPWD specification. Cable tray systems shall provide adequate mechanical strength to carry the maximum permissible uniformly distributed load. The main criterion for the SWL is safety in use of the product. For the declared application, the manufacturer shall declare the SWL to be tested. Following details are required to provide however not limited to this only.

- SWL in Kg/Mt for the cable tray lengths including joints, where applicable for one or more installation methods as required. i.e., mounted in the horizontal plane running horizontally on multiple spans.
- SWL in Kg/Mt for the fittings when not directly supported and the distance Y from the supports adjacent to the fittings.
- SWL in Kg for cantilever brackets and if used for cable tray only.
- SWL for pendants as a bending moment in Kg/mt and/or as a force in Kg
- Safety Factor : Load test with applying 1.7 times SWL. The sample shall sustain this increased load without collapsing. Buckling and deformation of sample are permissible at this loading.

Compliance for cable tray for SWL is to be provided by carrying out the relevant tests as per IEC 61537 on samples of the widest and narrowest width for each product type. The deflection of cable tray must be no more than 1/100th of the distance between two supports and tested in accordance with the standard IEC 61537. For the intermediate widths, the SWLs shall then be determined by interpolation of the test results.

Entire cable tray system shall be design with minimum Cable laying load capacity in kg per meter with unsupported free span of 1500mm as per below formulae.

- Minimum Cabling capacity Kg/ Mt = Cable laying area (in sqmt) x 2800. (support at 1500 mm span)
- For example. For 600 x 100 mm size tray Kg/ Mt = 0.6 x 0.1 x 2800 = 168 Kg / mt.

This load carrying capacity is to be reviewed based on actual requirement and if higher capacity is required than cable trays should be suitably design considering higher load accordingly. Span mentioned in this table is for reference only and actual span to be decided as per working layouts and site requirements.

Cable tray systems shall have adequate electrical continuity to ensure equipotential bonding and connection(s) to earth if required according to the application of the cable tray system. The calculated impedances shall not exceed 50 mohm across the joint and 5 mohm per meter without the joint as per IEC61537. All system components shall have adequate resistance against corrosion.

13.1 Ladder type cable tray

The cable tray shall be fabricated out of 2 mm thick slotted/ perforated MS sheets as channel sections, single or double bended. The channel sections shall be supplied in convenient lengths and assembled at site to the desired lengths. These may be galvanized or painted as specified.

13.1.1 The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 200mm length, shall be bolted on each of the two sides of the channel section with 8mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler and cable tray shall be scraped and removed before the installation.

13.1.2 The permissible uniformly distributed load for various type of cables trays and for different supported span shall be as per IS.

13.1.3 The width of the cables tray shall be chosen so as to accommodate all the cables In one tier, plus 30 to 50% additional width for future expansion. This additional width shall be minimum 100mm. The overall width of one cable tray shall be limited to 1000mm.

13.1.4 Factory fabricated bends, reducers, tee / cross junction. Etc shall be provided as per good engineering practice. The radius of bends, junctions etc. shall be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

13.1.5 The cable tray shall be suspended from the ceiling slab with the help of 10 mm dia MS round or 25 mm x 5 mm flats at specified spacing. Flat type suspenders may be used for channels up to 450 mm width bolted to cable trays. Round suspenders shall be threaded and bolted to the cable trays or to independent support angle 50 mm x 50 mm x 5mm at the bottom and as specified These shall be grouted to the ceiling slab at the other and through an effective means, as approved by the Engineer – in – charge, to take the weight of the cable tray with the cables.

13.1.6 The entire tray (except in the case of galvanized type) and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust, and finished with two coats of spray paint of approved make synthetic enamel paint.

13.1.7 The cable tray shall be bonded to the earth Terminal of the switch bonds at ends.

13.1.8 The cable tray shall be measured on unit length basis, along the center line of the cable tray, including bends, reducers, tees, cross joints, etc, and paid for accordingly.

13.1.9 The ladder type of cable tray shall be fabricated of double bended channel section longitudinal members with single bended channel section rungs of cross members welded to the base of the longitudinal members at a center to center spacing of 250 cm as per IS.

13.2 Perforated type cable tray

The cable tray shall be fabricated out of slotted/perforated MS sheets as channel sections, single or double bended. The channel sections shall be supplied in convenient lengths and assembled at site to the desired lengths. These may be galvanized or painted as specified. Alternatively, where specified, the cable tray may be fabricated by two angle irons of 50mmx50x6mm as two longitudinal members, with cross bracings between them by 50mmx5mm flats welded/bolted to the angles at 1 m spacing. 2mm thick MS perforated sheet shall be suitably welded/bolted to the base as well as on the two sides.

13.2.1 The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 200mm length, shall be bolted on each of the two sides of the channel section with 8mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler and cable tray shall be scraped and removed before the installation.

13.2.2 The maximum permissible uniformly distributed load for various all the cables trays and for different supported span are given in Table IV. The sizes shall be specified considering the same.

13.2.3 The width of the cables tray shall be chosen so as to accommodate all the cables In one tier, plus 30 to 50% additional width for future expansion. This additional width shall be minimum 100mm. The overall width of one cable tray shall be limited to 800mm.

13.2.4 Factory fabricated bends, reducers, tee / cross junction. Etc shall be provided as per good engineering practice. The radius of bends, junctions etc. shall be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

13.2.5 The cable tray shall be suspended from the ceiling slab with the help of 10 mm dia MS round or 25 mm x 5 mm flats at specified spacing (based on table III) Flat type suspenders may be used for channels up to 450 mm width bolted to cable trays. Round suspenders shall be threaded and bolted to the cable trays or to independent support angle 50 mm x 50 mm x 5mm at the bottom and as specified These shall be grouted to the ceiling slab at the other and through an effective means, as approved by the Engineer – in – charge, to take the weight of the cable tray with the cables.

13.2.6 The entire tray (except in the case of galvanized type) and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust, and finished with two coats of spray paint of approved make synthetic enamel paint.

13.2.7 The cable tray shall be bonded to the earth Terminal of the switch bonds at ends.

13.2.8 The cable tray shall be measured on unit length basis, along the center line of the cable tray, including bends, reducers, tees, cross joints, etc, and paid for accordingly.

13.3 Anchor Fastener

Anchor fastener shall be Hilti make and it will be install as per standard instruction from supplier / manufacturer and install in proper manners.

For Slab / RCC : Hilti make – Cat No. HKD-E M10/40 or HSV M8/75 or equivalent as per requirnments
For Wall / Bricks : Hilti make – Cat No. HRD-UGT 10x80/10

13.3.1 All installation of Anchor fastener has been approved by Hilti Technical staff and certified the same.

13.3.2 If require, 1% of total quantity Pull out test will be carried out at site.

13.3.3 Electrical contractor has to submit Material Test Certificate / Material Safety Data Sheet (MSDS) for all material to be used for hanging of cable tray.

MAKE OF MATERIAL-ELECTRICAL

SR.NO.	ITEM	STANDARD MAKE
1	LT PANELS (CPRI Certified)	SHIV SHAKTI ENGINEERS / ADVANCE PANEL / HITECH ENGINEERS / ACTIVE ENGINEERS / ADISHWARAM CORPORATION TENCOGROUP / JJ INDUSTRIES
2	DIESEL ENGINE	CATTERPILLER / CUMMINS INDIA/ PERKINS / KIRLOSKER / GREAVES / VOLVO PENTA
3	ALTERNATOR	STAMFORD / KIRLOSKAR / CROMPTON GREAVES / LEROY SOMER
4	SYNCHRONISING RELAY	WOOD WARD EASY GEN 3200 / STUKE / DEIF / DEEP SEA / EMCP-2 / GC 500
5	DISTRIBUTION BOARDS	LEGRAND - EKINOXE / SCHNEIDER - ACTI9 / HAGER/ LAURITZ KNUDSEN (L&K) / ABB /PANASONIC / SIEMENS
6	MEDIUM VOLTAGE CABLE	FINOLEX / POLYCAB / GLOSTER / KEI/AVOCAB/RR KABLE
7	CABLE TRAY (LADDER TYPE / PERFORATED)	OBO BETTERMANN / LEGRAND /DUDHAT / PROFAB / BILMAT
8	CABLE TRAY SUPPORT	MUPRO / FISCHER / HILTI
9	GI / AL FLOOR RACEWAY AND FLOOR JUNCTION BOXES	LEGRAND / OBO / MK / DUDHAT
10	PVC WALL RACEWAY	LEGRAND / OBO / MK
11	UPS	NUMERIC / SCHNEIDER / EATON /VERTIV
12	SPD (SURGE ARRESTER)	PHEONIX CONTACT / OBO / LEGRAND / SCHNEIDER / ABB
13	LT SWITCHGEAR (ACB)	LEGRAND -DMX WITH MP4.10 RELEASE / SCHNIEDER – NW EASYPACT 6E RELEASE / LAURITZ KNUDSEN (L&K) U-POWER OMEGA /ABB EMAX 2 / SIEMENS- 3WJ
14	LT SWITCHGEAR (MCCB)	LEGRAND – DRX / SCHNIEDER - CVS / LAURITZ KNUDSEN (L&K) – D SINE /ABB – TMAX / SIEMENS-3VJ
15	LT SWITCHGEAR (MCB)	LEGRAND - DX3 / SCHNIEDER – ACTI 9 / LAURITZ KNUDSEN (L&K)-AU /PANASONIC/ABB/HAGER/ SIEMENS-5TJ
16	LT SWITCHGEAR (CONTACTOR, RELAY, MPCB)	LEGRAND - CTX3/MPX3/RTX3/SCHNEIDER/LAURITZ KNUDSEN (L&K)/SIEMENS/ABB
17	METERS (ANALOG)	RISAHBH/SCHNEIDE/AE/ELMEASURE/NIPPEN/SECURE
18	METERS (DIGITAL)	AE/SCHNEIDER/LAURITZ KNUDSEN

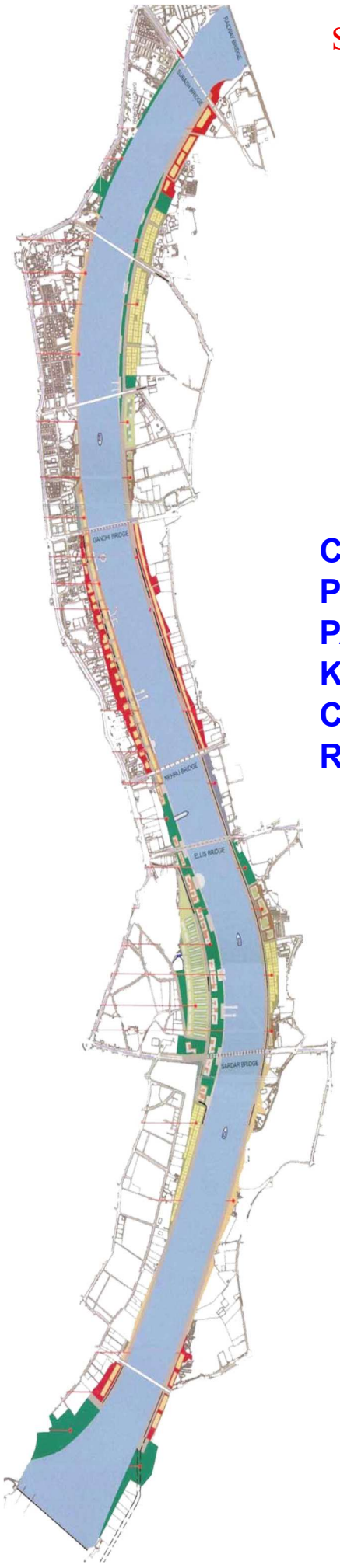
MAKE OF MATERIAL-ELECTRICAL

SR.NO.	ITEM	STANDARD MAKE
		(L&K)/ELMEASURE/NIPPEN/SECURE/LEGRAND PMX
19	ENERGY METER	SCHNEIDER/LAURITZ KNUDSEN (L&K) /NIPPEN/ELMEASURE/SECURE/LEGRAND
20	LOAD MANAGER	SCHNEIDER / LAURITZ KNUDSEN (L&K) /NIPPEN/ELMEASURE / LEGRAND
21	INDICATING LAMPS	SCHNEIDER / LAURITZ KNUDSEN (L&K) / SALZER
22	ELECTRIC TIMER	LEGRAND / LAURITZ KNUDSEN (L&K) / LEGRAND / SCHNEIDER / SIEMENS / ABB
23	ROTARY SWITCH	KEYCEE / SALZER
24	PUSH BUTTON AND PUSH-BUTTON SET	SCHNEIDER ELECTRIC / LAURITZ KNUDSEN (L&K) / LEGRAND / C&S / ABB
25	SELECTOR SWITCH	KEYCEE / SALZER / MECO
26	APFC PANEL & RELAY	LEGRAND / EPCOS / SCHNEIDER / Lauritz Knudsen (L&K) / SUBODHAN / VISHAY / SHREEM / NEPTUNE DUCATI
27	LT CAPACITORS	LAURITZ KNUDSEN (L&K) / EPCOS / LEGRAND / SCHNEIDER/VISHAY
28	LUGS	DOWELL'S / 3D / HEX JAINSON / COMET / HMI
29	BIMETALLIC LUGS	HMI / HEX / CONNECT / Dowells
30	CABLE GLAND	3D / COMET / HMI/POLYCAB / Dowells
31	PVC CONDUITS AND ACCESSORIES	PRECISION / ASTRAL / POLYCAB/AKG/ANCHOR/BBC
32	M.S. CONDUIT AND ACCESSORIES	AKG / BEC / STEELCRAFT
33	MODULAR SWITCHES, SOCKETS & OTHER ACCESSORIES	MK – ORNA / LEGRAND-MYRIUS NEXT GENERATION / SCHNEDIER-Miluz Lara / NORISYS /PANASONIC- EUROPA / LK- Entice/ENGLAZE /ABB-TVISHA Contractor to provide minimum 3 no sample of different make for approval of end user & consultant
34	METAL CLAD SOCKET WITH MCB	LEGRAND / HENSEL / SCHNEIDER / SCAME / SPELSBERG
35	PVC TAPE	STEEL GRIP / ANCHOR
36	PVC JUNCTION BOX	HENSEL / CLIPSAL / SPELSBERG / SCAME / SINTEX
37	WIRES FOR INTERNAL WIRING	FINOLEX / HAVELLS / POLYCAB / RR KABEL /ANCHOR / AKG / GLOSTER / KEI / RAJNIGANDHA

MAKE OF MATERIAL-ELECTRICAL

SR.NO.	ITEM	STANDARD MAKE
38	CONNECTORS (COLOURS AS PER PHASE & NEUTRAL)	WAGO / PHOENIX CONTACT/ CONNECTWELL
39	LED LIGHT FIXTURES	PHILIPS / WIPRO/ PANASONIC / JAQUAR / QLITE / KLITE
40	OUTDOOR DECORATIVE LIGHT LUMINAIRE	PHILIPS / WIPRO / BAJAJ/HAVELL'S / PANASONIC / JAQUAR / K LITE / NERI
41	CONTROL TRANSFORMER [PT / CT]	ASHMOR / AE / VIRAT / NARMADA / NEWTEK
42	PAINT	NEROLAC / ASIAN PAINTS
43	CEILING FAN / EXHAUST FAN	CROMPTON / BAJAJ / ORIENT / HAVELLS
44	FIRE EXTINGUISHER	CEASEFIRE / KANEX / SAFEX / MINIMAX
45	CHEMICAL EARTHING	CAPE / OBO/ JEF / DEHN / AXIS
46	MICROPROCESSOR RELAY & OTHER HT RELAY	SCHNEIDER / ABB / MICOM P111 / SIEMENS 7SJ12
47	ANNUCIATOR	LEGRAND / Lauritz Knudsen (L&K) / ABB / MINILAC
48	ANCHOR FASTENER	HILTI / 3M / MUPRO / WURTH / FISCHER
49	DWC PIPE	ALCORR / ASTRAL / DUTRON
50	RUBBER MATT - ISI MARK	JYOTI / MARUTI
51	ANTI-VIBRATION MOUNTING	DUNLOP / GERB / RASISTOFLEX OR EQUIVELANT
52	Fire Stopper / Mortar	Hilti, OBO, WURTH, FISCHER
53	Fire Stop Sealant / Foam	Hilti, OBO, WURTH, FISCHER
54	Fire Resi Cable Coating	Hilti, OBO, WURTH, FISCHER
55	LIGHT POLE	BAJAJ / KLITE / VOLMONT

SABARMTI RIVERFRONT DEVELOPMENT



Sabarmati River Front Development Corporation Limited

2nd Floor, Riverfront House,
B/h H.K Arts College,
Between Gandhi Bridge and Nehru Bridge,
Pujya Pramukh swami Marg
(River Front Road-West)
Ahmedabad-380009

BID DOCUMENT

CONSTRUCTION OF PUBLIC PLAZA AND UNDERGROUND PARKING FACILITY AT SANSKAR KENDRA - TAGORE HALL CAMPUS CONNECTING RIVERFRONT FOR SRFDCL.

Contract Package : SRFDCL

VOLUME-02

IV) Technical Specification-Electrical & ELV

1.0 CCTV SURVEILLANCE SYSTEM

1.1 4 MP Fixed Lense Dome Camera

1	Image Sensor	1 / 2.7" Progressive Scan CMOS
2	Effective Pixels	2560 × 1440
3	Min. Illumination	Color: 0.01 Lux @ F1.2, AGC ON; Color: 0.04 Lux @ F2.2, AGC ON; 0 lux with IR
4	Shutter Speed	1 s to 1/100,000 s
5	S/N Ratio	≥52 dB
6	Angle Adjustment	Pan : 0°-355°, Tilt : 0°-67°, Rotation : 0°-355°
7	Focal Length	2.8 mm @ F2.0
8	Iris Type	Fixed Iris
9	Field of View	2.8 mm @F2.0, horizontal field of view:110°,Vertical: 77.6°
10	Video Compression	H.265 / H.264
11	H.264 Compression Standard	Base Line / Main Profile / High Profile
12	H.265 Compression Standard	Main Profile @ Leve4.1 High Tier
13	Resolution	4MP(2560×1440), 1080P(1920x1080), 720P(1280x720), D1, CIF, 480 x 240
14	Max. Frame Rate	30fps @ 4MP (2560×1440)
15	Video Bit Rate	64Kbps - 5 Mbps
16	Multiple Streaming	Triple streams
17	Main Stream	60Hz: 4MP/3MP/1080P(1-30fps); 50Hz: 4MP/3MP/1080P(1-25fps)
18	Sub Stream	60Hz: 720P(1-15fps)/D1 /CIF (1-30fps); 50Hz: 720P(1-12fps)/D1/CIF (1-25fps)
19	Third Stream	60Hz: D1/CIF/480x240 (1-30fps); 50Hz: D1/CIF/480x240 (1-25fps)
20	Smart Codec	ROI, 3 zones
21	Quality Control	Five levels under VBR; Freely adjustable under CBR
22	Image Setting	time stamp, text overlay, flip & mirror, ROI, Saturation, Brightness, Chroma, Contrast, Wide Dynamic, Sharpen, white balance, video rotation, Scheduled profile settings, AGC
23	Day & Night	IR cut filter with auto switch
24	Wide Dynamic Range	Yes
25	IR Distance	Up to 30M
26	Digital Zoom	Yes
27	Image Features	Defog, BLC, HLC, 2D/3D DNR
28	Corridor Pattern	Yes
29	Video Privacy	4 zones video mask
30	Intelligent Video Analytics	Object removal (object left/missing detection), scene change and video blur detection, intrusion and line crossing
31	Alarm Triggers	Motion detection, Intelligent video analytics, Network disconnect, video tampering, IP address conflict, illegal login, SD Card full, SD Card error, Alarm input, Alarm output
32	Edge Storage	Built-in micro SD card slot, up to 128GB
33	Network Protocol	TCP/IP, UDP, DHCP, NTP, RTSP, PPPoE, DDNS, SMTP, FTP, UPnP, Unicast, Multicast, ICMP, HTTP, HTTPS, DNS, DDNS, RTP, RTCP, IGMP, 802.1X, QoS, Ipv4, Ipv6
34	Cyber Security	HTTPS / IP Filter / IEEE 802.1X / Blacklist & whitelist / account security / telnet access control / serial password

35	Online Connection	Support simultaneous monitoring for up to 4 users; Support multi-stream real time transmission
36	API	ONVIF Profile (S & G)
37	Network	1 RJ45 10M/100M self-adaptive Ethernet port
38	Hardware Reset	Yes
39	Operating Temperature	- 30 °C to 60 °C
40	Operating Humidity	10 % to 90 % relative humidity
41	Ingress Protection	IP67
42	Vandal Resistance	IK10
43	Power Supply	DC12V / PoE
44	Power Consumption	< 6W
45	Warranty	3 years
46	Emissions	FCC Part 15.107 Class A, FCC Part 15.109 Class A , EN 55032, EN 55035 (IEC 61000-4-2, IEC 61000-4-3, IEC 61000-4-4, IEC 61000-4-5, IEC 61000-4-6, IEC 61000-4-8)
47	Immunity	EN 55030-4
48	Safety	UL 62368-1, IEC 62368-1 EN 62368-1, CAN/CSA C22.2 No. 62368-1-14, J62368-1, AS/NZA 62368.1
49	Environment	RoHS (IEC 62321-3-1, IEC 62321-5, IEC 62321-4, IEC 62321-6, IEC 62321-7, IEC 62321-7-2, IEC 62321-8), WEEE, REACH
50	NDAA Compliant	Yes
51	BIS Certified	Yes
52	Support	• The OEM shall have a self-owned support Service Center and RMA in India from last 5 years and Toll-Free number. • The OEM shall be registered in India for more than 10 Years and present globally for more than 20 years

1.2 4 MP Fixed Lense Bullet Camera

1	Image Sensor	1 / 2.7" Progressive Scan CMOS
2	Effective Pixels	2560 × 1440
3	Min. Illumination	Color: 0.01 Lux @ F1.2, AGC ON; Color: 0.04 Lux @ F2.2, AGC ON; 0 lux with IR
4	Shutter Speed	1 s to 1/100,000 s
5	S/N Ratio	≥52 dB
6	Angle Adjustment	Any angle
7	Focal Length	3.6 mm @ F2.2
8	Iris Type	Fixed Iris
9	Field of View	6 mm @ F2.0, horizontal field of view:110°,Vertical: 77.6°; 3.6 mm@F2.2, horizontal field of view: 89°, Vertical: 58°
10	Lens Mount	M12
11	Video Compression	H.265 / H.264
12	H.264 Compression Standard	Base Line / Main Profile / High Profile
13	H.265 Compression Standard	Main Profile @ Leve4.1 High Tier
14	Resolution	4MP(2560×1440), 1080P(1920x1080), 720P(1280x720), D1, CIF, 480 x 240
15	Max. Frame Rate	30fps @ 4MP (2560×1440)
16	Video Bit Rate	64Kbps - 5 Mbps
17	Multiple Streaming	Triple streams
18	Main Stream	60Hz: 4MP/3MP/1080P(1-30fps); 50Hz: 4MP/3MP/1080P(1-25fps)
19	Sub Stream	60Hz: 720P(1-15fps)/D1 /CIF (1-30fps); 50Hz: 720P(1-12fps)/D1/CIF (1-25fps)

20	Third Stream	60Hz: D1/CIF/480x240 (1-30fps); 50Hz: D1/CIF/480x240 (1-25fps)
21	Smart Codec	ROI, 3 zones
22	Quality Control	Five levels under VBR; Freely adjustable under CBR
23	Image Setting	time stamp, text overlay, flip & mirror, ROI, Saturation, Brightness, Chroma, Contrast, Wide Dynamic, Sharpen, white balance, video rotation, Scheduled profile settings, AGC
24	Day & Night	IR cut filter with auto switch
25	Wide Dynamic Range	Yes
26	IR Distance	Up to 50M
27	Digital Zoom	Yes
28	Image Features	Defog, BLC, HLC, 2D/3D DNR
29	Corridor Pattern	Yes
30	Video Privacy	4 zones video mask
31	Intelligent Video Analytics	Object removal (object left/missing detection), scene change and video blur detection, intrusion and line crossing
32	Alarm Triggers	Motion detection, Intelligent video analytics, Network disconnect, video tampering, IP address conflict, illegal login, SD Card full, SD Card error, Alarm input, Alarm output
33	Edge Storage	Built-in micro SD card slot, up to 128GB
34	Network Protocol	TCP/IP, UDP, DHCP, NTP, RTSP, PPPoE, DDNS, SMTP, FTP, UPnP, Unicast, Multicast, ICMP, HTTP, HTTPS, DNS, DDNS, RTP, RTCP, IGMP, 802.1X, QoS, Ipv4, Ipv6
35	Cyber Security	HTTPS / IP Filter / IEEE 802.1X / Blacklist & whitelist / account security / telnet access control / serial password
36	Online Connection	Support simultaneous monitoring for up to 4 users; Support multi-stream real time transmission
37	Remote Monitoring	Web viewer browsing
38	API	ONVIF Profile (S & G)
39	Network	1 RJ45 10M/100M self-adaptive Ethernet port
40	Onboard Storage	Built-in micro SD/SDHC/SDXC slot
41	Hardware Reset	Yes
42	Operating Temperature	- 30 °C to 60 °C
43	Operating Humidity	10 % to 90 % relative humidity
44	Ingress Protection	IP67
45	Vandal Resistance	IK10
46	Power Supply	DC12V / PoE
47	Power Consumption	< 10W
48	Emissions	FCC Part 15.107 Class A, FCC Part 15.109 Class A , EN 55032, EN 55035 (IEC 61000-4-2, IEC 61000-4-3, IEC 61000-4-4, IEC 61000-4-5, IEC 61000-4-6, IEC 61000-4-8)
49	Immunity	EN 55030-4
50	Safety	UL 62368-1, IEC 62368-1 EN 62368-1, CAN/CSA C22.2 No. 62368-1-14, J62368-1, AS/NZA 62368.1
51	Environment	RoHS (IEC 62321-3-1, IEC 62321-5, IEC 62321-4, IEC 62321-6, IEC 62321-7, IEC 62321-7-2, IEC 62321-8), WEEE, REACH
52	NDAA Compliant	Yes
51	BIS Certified	Yes
52	Support	• The OEM shall have a self-owned support Service Center and RMA in India from last 5 years and Toll Free number. • The OEM shall be registered in India for more than 10 Years and present globally for more than 20 years

1.3 48 Channel Embedded Network Video Recorder

1	IP video input	48CH
2	Incoming bandwidth	512Mbps
3	Outgoing bandwidth	512Mbps
4	Recording resolution	Supports 12MP, 8MP, 5MP, 4MP, 3MP, 2MP, 720p, D1, CIF
5	Video o/p interfaces	HDMI 2.0 – 1 Port (Main)
6	Monitor Output Layout (Split Display)	1x1, 2x2, 3x3, 4x4, 1+5, 1+7, 3+4, 2+8, 1+12, 1+9, 4+9, 2+12, 5x5, 6x6, 8x8 and Sequential
7	Audio o/p	1 Channel, RCA Port
8	Two Way Audio Input	1 Channel, RCA Port
9	Compression technique	H.265/H.264/MJPEG or better
10	Live View/Playback resolution	Up to 12MP resolution.
		Live/Playback Channels for 4K @ 30FPS = 4 Channels
		Live/Playback Channels for 1080p @ 30FPS = 16 Channels
		Live/Playback Channels for 720p @ 30FPS = 32 Channels
		Live/Playback Channels for D1 @ 30FPS = 48 Channels
11	Video Export	Video Export file format Raw/AVI
		Separate AVI files for every channel.
12	Synchronous playback	16 channels @ 1080P on the Local HDMI Client
13	Record Stream	Single Stream Recording (either Main stream or Sub stream)
14	Recording Options	a. Continuous All Channels
		b. Scheduled
		c. Event Based
15	Simultaneous Recording Resolution	
		All Cameras: 4MP Resolution, 30FPS, H.265: Simultaneous Recording Capacity upto 48 Channels
		All Cameras: 8MP Resolution, 30FPS, H.265: Simultaneous Recording Capacity upto 36 Channels
		All Cameras: 12MP Resolution, 30FPS, H.265: Simultaneous Recording Capacity upto 24 Channels
16	SATA interfaces	8 SATA @ 18TB each supported
17	RAID Arrays	RAID 0 / 1 / 5 / 10 supported
18	Protocol Support	TCP/IP, UDP, DHCP, NTP, RTSP, PPPoE, SMTP, FTP, UPnP, DDNS, RTP, IPV4, DNS, RTCP, ICMP, HTTP, QoS, ARP
19	Reset Button	Yes
20	Mobile App Support	Android, iOS
21	NVR Operating System	Linux
22	Network Interfaces	2 X RJ-45 10/100/1000 Mbps self-adaptive Ethernet interface
23	USB interface	Total 3 USB ports: 2x USB 2.0 and 1x USB 3.0
24	ONVIF	ONVIF Profile S
25	Alarm I/O	2IN / 1OUT
26	Alarm Mode	Manual, Sensor, Motion, Exception, Smart Events, etc.
27	Alarm Action	Record, Snapshot, Call Preset, E-mail, Buzzer
28	Power supply	100 to 240 VAC
29	Working Temperature	0°C to +50°C
30	Working Humidity	5% to 95% RH Non-Condensing
31	Certification	CE
		FCC
		BIS
32	NDAA Compliant	Yes

2.0 PASSIVE NETWORKING SYSTEM

2.1 Cat 6 Cable

1	Insulation	Solid PE Ø0.96 mm
2	Conductor	23 AWG solid bare copper with a Diameter ≥0.56 mm
3	Separator	X shaped separator
4	Type of Sleeve	PVC / LSZH
5	Maximum Attenuation	32.8 dB per 100m
6	Min Next (dB)	38.3
7	ACRF (dB/100m)	18.8
8	Return Loss (dB)	17.3
9	Electrical Specifications at 20 Deg C	
10	Type	Unshielded Twisted Pair, Category 6, as per IEC 61156-5
11	Max linear resistance	95 Ohms per KM
12	DC dielectric strength	1KV/ 1 minute
13	Minimum Insulation Resistance	5000 Mohm.km
14	Minimum Propagation Speed	>65%
15	Characteristic Impedance from 1 to 100 MHz	100 Ohm ± 15%
16	Mechanical Features	
17	Diameter Over Insulation (mm)	1.02 ± 0.06
18	Cable Diameter (mm)	6.1 ± 0.3
19	Min. bending radius when laying (mm)	25
20	Others Specifications	
21	Usage Temperature	-20 to + 60 degree C
22	Approvals	UL Certified
23		3P Certified
24		ETL verified to TIA / EIA Cat 6
25	Packing	Box of 305 meters
26	Color	Blue RAL 5015
27	Performance characteristics to be provided along with bid for CAT6 @250 MHz	The cable NEXT, PSNEXT, FEXT, ELFEXT, PSELFEXT test result should meet & exceed the performance requirement as per as per ANSI/TIA 568C.2, ISO/IEC 11801, & EN50173.
28	Warranty	25-year systems warranty

2.2 Copper Patch panel

1	CAT6 RJ45 straight patch panel & connector – 24 port loaded	UTP
2	Standards and Approvals	Compliant with standards: ISO/IEC 11801 Edition 3.0 CENELEC EN 50173-1 2007 ANSI/EIA/TIA 568 C2-1 IEC series 60603-7, NFC 20730, Standard 8877 – 603.7
3	GENERAL CHARACTERISTICS	Equipped with new-generation Soluclips for automatic fixing (screwless) on cabinet and enclosure uprights
		Universal mounting of all cabinets or enclosures

		The panels automatically earth each connector
		Equipped with rear cable guide to hold cable during maintenance
		Equipped with 4 cassettes of 6 RJ45 Cat. 5E connectors with toolless fast connection, marked 568 A/B
		Supplied with coloured labels
		Conforming to standards ISO/IEC 11801 edition 3.0 (2017) and EIA/TIA 568 C2-1
		19" panel - 1 U
		Cassettes removed automatically by simple pressure
		Each connector can be removed individually
		system makes it easy to spread pairs before fitting them onto the connector.
		Spreading the cables allows you to ensure that a pair-breakage distance of 13 mm is kept between each pair.
		Spreading pairs at 90° to the cable ensures the best possible performance.
4	POSITIONING	The connectors are connected from the front without a special tool.
		Connectors clip onto the panel individually
		No need for cable ties: the cable is held in its cable guide.
5	Material characteristics	Panel: DC01 galvanised sheet steel
		Contacts: gold/nickel, thickness of gold > 0.8 µm minimum
		Metal parts: bronze, nickel, platinum, gold
		Polycarbonate PBT
6	Electrical characteristics	Breakdown voltage: 1000 V
		Contact resistance: 20 mΩ
		Insulation resistance: 500 MΩ under 100 V DC
		Withstand performance to a POE signal up to 50 W
7	Mechanical characteristics	Max. number of connections and disconnections: 5 without replacing the wire
		Endurance: 2500 operations (plug-in/pull-out)
		IK03
8	Climatic characteristics	Operating temperature: -40°C to +70°C
		Humid heat 21-day cycle
9	Dimensions	Panel : 482.5(W) x 321.7(D) x 43.85(H) in MM
		Connector: 17.5 (W) x 48.15 (D) x 20.5 (H) in MM
10	TYPICAL RJ45 CONNECTION	Takes the following plugs: RJ 11 (4 contacts), RJ 12 (6 contacts), RJ 45 (9 contacts).
		EIA/TIA 568 A and B dual colour code on terminals: - UTP (8 contacts) - FTP (9 contacts)
11	Conductors Supported	Single-wire: 0.5 to 0.65 mm, AWG 22 to 25
		Multiple-wire: AWG 26
		Polyethylene conductor insulation: max Ø with insulation 1.58 mm
		Number of wires to be connected per connection: 1
		RJ45 connectors are equipped with a locking nut. They do not require a special tool and can be re-wired if a mistake is made.
12	Earthing	The panels offer automatic earthing of each connector
13	Performance Warranty	The performance warranty for over all installation shall be for 25 years by manufacturer.
14	Capacity	Patch panel should accept 6 port Fibre cassette to connect fibre other than Copper Connectors, if required

2.3 Cat 6 RJ45 Information Outlet

1	CAT6 RJ45 Information Outlet	UTP Cat 6 RJ 45 Sockets
2	Standards and Approvals	The electrical performance of installation outlet shall meet or exceed requirement as per - ISO/IEC 11801 Edition 2; - CENELEC EN 50173-1 2007; - ANSI/EIA/TIA 568-C.2; - IEC series 60603-7
3	Performance characteristics to be provided for CAT6 @ 250 MHz	The information outlet NEXT, PSNEXT, FEXT, ELFEXT, PSELFEXT and return loss should be verified
4	Connection of RJ 45	Should Accept RJ11 (4 contacts), RJ12 (6 contacts), RJ45 (9 contacts).
5	Conductors Supported	Single-wire: 0.5 to 0.65 mm, AWG 22 to 25 Multiple-wire: AWG 26 Polyethylene conductor insulation: max Ø with insulation 1.58 mm
6	Shutter	Information outlet should have transparent shutter for protection against dust when not used.
7	Tool Less Crimping	The information outlet termination should be of self crimping type without use of 110 punching tool requirement
8	Material Specifications	
9	Body	Contacts :gold/nickel, minimum thickness of gold > 0.8 µm
10		Metal parts: bronze, nickel, platinum, gold
11		The information outlet shall be made of high impact PBT Polycarbonate plastic material
12		For STP Products the body and spreader are made of metal alloy with a copper-nickel coating.
13	Break Down Voltage	Greater than or equal to 1000V
14	Contact Resistance	Less than or equal to 20mOhms
15	Insulation Resistance	Greater than or equal to 500 M Ohm at 100 V DC
16	Load Testing	Connector should be tested and guaranteed under PoE restrictions, IEEE 802.3af standard and PoE+, draft standard 802.3at, up to 2500 on-load connections / disconnections. Tested with 2 simultaneous PoE+ circuits for a minimum total power of 50 W
17	Maximum no of Connections/ Re connections	5 without refreshing the wiring.
18	Endurance	2500 movements (plug insertion/withdrawal). IK03
19	Temperature	-40 Deg C to +70 Deg C

2.4 Face-Plate

1	Material	Polycarbonate Hi-Grade Plastic FR Grade & UV Resistant 850 degree C/ Glow Wire Test
2	Compatibility	The face plate should be compatible for Cat5e, Cat6 and Cat6A range of RJ45 and AV connectors.
3	Size	The face plate Size should be of minimum 86x86mm

2.5 Cat 6 Patch Cord

1	Type: CAT6 Patch cords - 1, 2, 3, 5 Mtr	U/ UTP, Cat 6 Patch Cord

2	Sleeve	PVC or LSZH
3	Performance at 250MHz	Should be as per Standards - IEC 61935-2 - Ed. 3.0 ISO/IEC 11801
4	Usage Temperature	– 20 to + 60°C
5	Minimum Next (dB)	Minimum NEXT (dB)
6	Length	
7	1 Meter	39.1
8	2 Meter	38.7
9	3 Meter	38.3
10	5 Meter	38
11	Return Loss (dB)	Return Loss (dB)
12	Length	14
13	1 Meter	14
14	2 Meter	14
15	3 Meter	14
16	5 Meter	14
17	Technical and Mechanical Features	
18	Type	UTP
19	Diameter over Insulation (mm)	0.97
20	Cable Diameter (mm)	6
21	No of Twists	500
22	No of insertions	750
23	AWG gauge	24
24	Tensile Strength of the cord	≥ 50 N
25	Electrical Features	
26	Contact Resistance	Less than 20 m Ohm
27	Total Resistance of the cord	Less than 5 Ohms
28	Resistance per 100m of cable with cord	Less than 14 Ohm
29	DC Dielectric Strength	1 KV/ 1 min

2.6 PVC Pipe

1	Applied standard	IS:9537: PART-3: 1983
2	Outside Diameter & inside Diameter	Normal Size=25mm
		Outside Diameter=25mm
4	Length	STANDARD LENGTH OF CONDUIT IS 3 METERS.
5	Bending Test	AFTER THE TEST ON CONDITIONED SAMPLES, THE SAMPLES SHALL SHOW NO CRACKS VISIBLE TO NORMAL TO CORRECTED VISION WITHOUT MAGNIFICATION. BENDING TEST IS APPLICABLE ONLY UPTO 25MM
6	Thickness	LIGHT: 1.25-1.45 (APPROX)
		MEDIUM: 1.60-1.80 (APPROX)
		HEAVY: 2.00-2.20 (APPROX)

7	Compression Test	FOR, LIGHT:25% OF COMPRESSION ALLOWED UNDER LOAD OF 320N CONDUIT AND 10%ALLOWED AFTER RELEASING THE LOAD.
		FOR, MEDIUM:25% OF COMPRESSION ALLOWED UNDER LOAD OF 750N CONDUIT AND 10% ALLOWED AFTER RELEASING THE LOAD.
		FOR, HEAVY:25% OF COMPRESSION ALLOWED UNDER LOAD OF 1250N CONDUIT AND 10% ALLOWED AFTER RELEASING THE LOAD.
8	Impact Test	AFTER THE TEST ON CONDITIONED SAMPLES, THERE SHALL BE NO SIGH OF DISINTEGRATION AND CRACK VISIBLE TO NAKED EYE IN AT LEAST NINE OUT OF TWELVE SAMPLES.
9	Collapse Test	AFTER THE TEST ON CONDITIONED SAMPLES, THE APPROPRIATE GAUGE PASSED THROUGH THE SAMPLE CONDUIT.
10	Resistance to Heat	AFTER THE TEST. DIA OF IMPRESSION ON THE SAMPLE SHALL NOT EXCEED 2MM.
11	Resistance to Burning	FLAME SHALL DIE OUT IN LESS THAN 30 SECOND AFTER REMOVEAL OF BURNER.
12	Electrical	DIELECTRIC STRENGTH@NO BREAKDOWN OF CONDITIONED SAMPLE SHALL OCCUR AT THE VOLTAGE OF 2000V & SOHZ FREQUENCY FOR 15 MINUTES.
	Characteristics	INSULATION RESISTANCE@THE INSULATION RESISTANCE ON CONDITIONED SAMPLES SHALL NOT BE I THAN 100 MEG. OHM.

2.7 HDPE Pipe

1	Colour of Duet	Red, Green, Blue, Orange, Gray, Violet, Brown, Requirement
2	Dimensions &Tolerances	
2.1	Nominal outside Diameter	25.00+0.15
2.2	Wall Thickness	1.50 to 1.60mm
2.3	Thickness of Inner layer	0.17 to 0.20mm
2.4	Lubrication	Permanently lubricated for blowing of Optical Fiber Cable
2.5	Ovality	1.4 mm max.
2.6	Length of each Duct	1000 +100
3	HDPE Raw Material	
3.1	Density	0.940 to 0.958 at 27C
3.2	Melt Flow Rate	0.2 to 1.10 at 190" C under 5 kg Load
4	Visual Appearance	
4.1	Surface Finish	Satisfactory
5	Performance Requirement	
5.1	Heat Reversion	Max.3% in longitudinal Direction
5.2	Hydrostatic Pressure Resistance test	ACCEPTANCE Test Duration:48 hrs at 80C Induced Stress:3.8 Mpa Type Test Duration:165 hrs at 80C Induced Stress:3.5 Mpa
5.3	Tensile Strength	20 Min
5.4	Elongation	600 Min

5.5	Environment Stress Crack Resistance with 10% legal at 50, 1 deg cel.	No Crack or Split at 50 deg C for 96 hrs.
5.6	Impact Strength	Striker weight 10 kgs

3.0 FIRE ALARM SYSTEM

3.1 Fire Alarm Control Panel

1	Loop Capacity - 127 Devices + 127 Base Sounder & Base Sounder Beacon
2	Panel Capacity – 6 Loops inbuilt and expandable upto 8 Loops
3	System Architecture – Wired and Wireless devices on the same loop
4	Display - Full colour 800 x 480 LCD with resistive touch screen and automatic backlight dimming
5	Software zones 2000, Software groups 5000
6	10000 Event Logs
7	Detection loop current - 500 milliamps each
8	Sounder circuits - 4 each rated at 2.5A, 24V DC, programmable
9	Auxiliary 24V supply 1 24 V dc fused at 500 milliamps
10	Auxiliary 24V supply 2 24 V dc fused at 500 milliamps
11	Default relays Fault, Fire, Alarm, Programmable 1 and Programmable 2 (all reprogrammable) Programmable inputs 3, activated by volt free contacts
12	RS485 Hard wired network of 127 panels
13	IP rating - IP 30
14	LPCB Certified
15	Compliant with EN54-2, EN54-4, EN54-13

3.2 Addressable Multi-Detector

1	Electronic addressing Dual bi-color LED indication for 360° viewing angle
2	3 User selectable modes
3	Variable sensitivity 1% to 4.5% or better
4	Electronically Addressed
5	Operating Voltage 17 – 41 V dc
6	Low Power Mode (typ) 120 µA
7	Quiescent Current (typ) 400 µA
8	Variable sensitivity 1% to 4.5% or better
9	Alarm Current 9.1mA (excluding remote indicator)
10	Removable Chamber
11	Dual Heat Elements
12	Stainless Steel smoke chamber mesh
13	Heat Sensing limit 0 to 88 Degree C
14	LPCB Certified
15	VDS Approved

3.3 Addressable Multi Heat Detector

1	Electronic addressing Dual bi-color LED indication for 360° viewing angle
2	3 User selectable modes

3	Variable sensitivity 1% to 4.5% or better
4	Electronically Addressed
5	Operating Voltage 17 – 41 V dc
6	Low Power Mode (typ) 110 µA
7	Quiescent Current (typ) 350 µA
8	Alarm Current 9.1 mA (excluding remote indicator)
9	Removable Chamber
10	Dual Heat Elements
11	Heat Sensing limit 0 to 88 Degree C
12	LPCB Certified
13	VDS Approved
14	IP Rating: IP 67 or Higher

3.4 Optical Beam Detector

1	Operating Range 5 – 100 m
2	Transmitter- receiver Type
3	Automatic compensation
4	Automatic signal strength adjustment
5	Features a Latching or Non-Latching Fault Relay
6	Quiescent Current (typ) 250 µA
7	Maximum Current In Alarm 50 mA
8	Operation Range 5 – 100 m (between emitter & receiver)
9	Sensitivity Range 25%, 50% and 60% obscuration (selectable)
10	LPCB Certified
11	VDS Approved

3.5 Addressable Single Zone Module

1	Loop Powered
2	No. of Conventional Detector support - 6
3	No. of address consumed on loop - 1
4	Electronic addressing
5	In-Built Short Circuit Isolator
6	Operating voltage 17 - 41 V dc
7	Low Power Mode (0.75s) 170 µA
8	Quiescent current 300 µA
9	Current consumption 22 mAµ 20 % (polling)
10	Current in short-circuit 8 mA (maximum short-circuit current 1 A)
11	LPCB Certified
12	VDS Approved

3.6 Resettable Manual Call Point

1	Electronic addressing Blinking LED for visual supervision
2	Two wire communication
3	In-Built Short Circuit Isolator
4	Operating Voltage 17 - 41V dc

5	Low Power Mode 180µA (max), 100µA (typ)
6	Quiescent Current 350µA (max), 250µA (typ)
7	Alarm Current 10.0mA (max), 5mA (typ)
8	Resistance in positive 100mΩ when closed (max), 100kΩ when open (min)
9	Short-circuit threshold (typ) 430Ω
10	LPCB Certified

3.7 Loop Powered Wall Sounder Beacon

1	Electronic addressing
2	Variable Sound Output 90 ~ 102 dB(A) (±2 dB(A)) output at 1 metre
3	51 User-Selectable Tones (all tones EN54-3 compatible)
4	'O' Rated Beacon to EN54-23
5	Minmum 13 volume setting
6	Sounder and Beacon can operate independently
7	360° Harmonic sound output
8	0.5 or 1Hz flash frequency
9	Auto-Shutdown feature prevents noise-pollution
10	Operating Voltage 17 ~ 41 Vdc
11	Low Power Mode (typ) 150 µA
12	Quiescent Current (typ) 200 µA
13	Sounding Current (typ) 2 mA (90 dB(A) (±2 dB(A)) @ 1 m) ~8 mA (102 dB(A) (±2 dB(A)) @ 1 m) Additional Current when Beacon active + 7 mA
14	Tone Frequency Range 300 Hz ~ 2850 Hz
15	LPCB Certified

3.8 Addressable Single Input Module

1	Electronic addressing
2	1 no. Monitored Input
3	Electronic Programming
4	Operating voltage 17 - 41Vd.c.
5	Quiescent Current / Alarm Current 150µA (at 41V) max
6	LPCB Certified
7	VDS Approved

3.9 Addressable Single Output Module

1	Electronic addressing
2	1 no. Monitored Output
3	Electronic Programming
4	Operating voltage 17 - 41Vd.c.
5	Quiescent Current / Alarm Current 150µA (at 41V) max
6	LPCB Certified

4.0 PUBLIC ADDRESS SYSTEM

4.1 EVAC PA Controller

1	Priority mixing with ducking, attack and release
2	16x4 DSP matrix mixing
3	5 band parametric PEQ in the outputs
4	up to 10s delay per output
5	Gain adjustment in the in- and outputs

6	Compressor on the inputs
7	Limiters on the inputs
8	Cross point matrix level adjustment with ducking level, fade in and fade out time
9	2 mic/line inputs (System s/n >= 106dB) – 2x Euro Style - 2x cinch
10	4 separate call station RJ45 input busses, each can be daisy chained up to 4 call stations
11	4 output channels for daisy chaining amplifiers via RJ45
12	12 input contacts; 6x voltage free (isolated) + 6x Supervised, to ensure compliancy to all different standards (like VDE0833 & NEN2575)
13	12 output contacts; 1x Relay + 12 Open Collector
14	6 High power output contacts (1A)
15	8 Analog input contacts with 256 steps resolution
16	Four input channels (100V, 70V) + 2 spare channel inputs (100V, 70V)
17	Real time clock with summertime and wintertime switching
18	DCF77 receiver sync input
19	Event scheduler
20	12 zone outputs (100/70V)
21	12 zone status LED (active – green, fault – yellow, alarm – red)
22	6 system status LED (general fault, system fault, alarm mode, power indicator, standby mode, network connection status)
23	Internal router pcb: 2x 2ch x 6zone (2 separate channels can be provided on each 6 zones. Blocks can be daisy chained)
24	Controller shall be configurable as 6 A/B zones or 12 single zones
25	Internal sounder
26	System access shall have password protection
27	CAN bus between system components
28	Based on a fully digital platform
29	Network prepared (remote system racks)
30	24V DC Input
31	It shall allow up to 12 controllable local audio inputs
32	Operating temperature: -5 C to +45 C
33	Fiber Module is able to send and receive Dante audio to and from other Controllers with an Fiber Interface Module.
34	The transmission of up to 16 digital audio input signals and 16 digital audio output channels with low latency is possible with the Fiber interface Module
35	Gigabit Ethernet Interface - 1000 Mbit/s fullduplex Ethernet Interface, IEEE 802.3u compatible
36	Secondary Gigabit Ethernet Interface - Second Ethernet Interface for the connection of a redundant network to establish fault-tolerant systems
37	Status LEDs - Link, Activity and Gigabit active status indication for each Ethernet interface
38	EN 54-16 system certification

4.2 2 X 500 W Amplifier

1	2x 500 Watt Class D amplifier
2	4 channel input on RJ45 connector, amp link in and out
3	(4 channel dynamic input channel switching for each amplifier)
4	Local input on amplifier:
5	Enabled via software configuration or automatically selected when amplifier address is set to address "0",

6	System channel 4 will be used as supervision channel in case local inputs are used.
7	Loop through on RJ45 connector (4 channels)
8	Amplifier efficiency >= 78%
9	Limiter prevents audible distortion
10	AC Power switch on rear side
11	24V DC Input
12	Front to rear air ventilation
13	Signal to noise ratio, A-weighted: >104 dB

4.3 Call Station

1	Five menu/function keys (pre-programmed) – four buttons shall provide each 1 LED (two LED's shall be 2 green and 2 LED's shall be yellow).
2	Green led on the microphone which is active during a call
3	15 function and speed dial buttons (customizable), two LEDs (green/red) per button.
4	Button functions shall be programmable such as:
5	Zone select, source select, level control, emergency on/off, message on/off, failure acknowledge/reset.
6	switching output trigger on/off or 0 to 10V, select scheduled events, scheduled event on/off.
7	Fascia cover with transparent areas for customizable labels.
8	Multilanguage LCD display informs about system status, system faults, selected zones, source select, clock, different kind of additional (failure) messages shall be free configurable.
9	Supervised electret microphone, with limiter and a speech filter for excellent speech intelligibility.
10	CAT5 cable for data and audio connection to controller (can bus, up to 1000 meter).
11	It shall be possible to daisy chain 4 call stations.
12	It shall receive audio and operational control signals from the controller and report its status to the system controller.
13	Internal monitoring with error logging– complying with all relevant national and international standards.
14	Supply voltage: 15–58 V DC
15	Operating temperature: -5° to 45° C
16	External Connectors: 1 PCA BUS connector , 1 Audio Source , 1 Microphone input (phone jack), 1 EXT connector

4.4 6W ceiling mount speaker

1	6W ceiling mount speaker with excellent speech & music reproduction
2	Rated Power: 6Watts, Power Tapping: 6/3/1.5W
3	Effective frequency range(-10 dB) : 65 Hz to 20 KHz
	- SPL at rated power (1Khz at 1 m) 95 dB
4	Opening Angle 1 KHz / 4 KHz:: 180° / 49°

MAKE OF MATERIAL-ELV

SR.NO.	ITEM	STANDARD MAKE
1	CCTV SYSTEM	TYCO / BOSCH / MOBOTIX / HONEYWELL – PROJECT SERIES
2	FIRE ALARM PANEL	HOCHIKI / BOSCH / FIKE / TYCO / SIEMENS / HONEYWELL NOTIFIER
3	PA SYSTEM	BOSCH / ATIES / TOA
4	Signal Cable	Polycab / finolex /RR Kable/Caliplast