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

RIVERSIDE SAVORIES-CONSTRUCTION OF BUILDING WITH TUNNEL ROAD AND BETWEEN NEHRU BRIDGE TO ELLISBRIDGE, RIVERFRONT-WEST.

Contract Package : SRFDCL

VOLUME-02

IV) Technical Specification-Ele & 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 details. 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, labor 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 chiseling 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 labor 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 LT 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 equipments, 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.

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 UNITISED SUBSTATION – OUTDOOR DUTY

Technical Specification For 11/0.415kv High Voltage/Medium Voltage Compact Pre-Fabricated Packaged Substation.

1.1 Scope of Work

The specification covers design, engineering, manufacture, assembly, Testing, Inspection, Packing, Transportation and supply and on-site sample commissioning of 11/0.415 kV Packaged Substation with all safety accessories, tools and tackles. The substation shall be designed, manufactured and tested as per IEC 61330. The substation shall be tested for internal arc test.

Test methods of prefabricated sub-station which are cable connected to be operated from inside or outside for alternating current of primary rated voltage up to 11KV and for a transformer rating as per tender for service frequencies. The prefabricated sub-station is to be installed at ground level.

1.2 Bill of Quantity

Each offer of Packaged Substations shall consist of

a.	11 KV HT VCB Unit (SF6/VCB type)	1 No.
b.	500 kVA 11/0.415 KV, Dry type Hermitically sealed Distribution transformer	1 No.
c.	Bus bar connection between LT terminals of transformer to ACB and further Connections to MCCB	1 Set
d.	LT MCCB, microprocessor-based release 630 Amps corresponding to Transformer capacity	1 Set
e.	Enclosure for entire substation	
f.	Metering CT	

1.3 Site Conditions

The equipment covered under this specification is for Outdoor installation and should be suitable for use at the sites across India. For the prevailing climatic conditions.

1. TEMPERATURE: The reference ambient temperature is to be taken as 43.3°C as per IS 9676.

   - Maximum ambient air temp : 45°C
   - Maximum daily average ambient temp : 40°C

2. RELATIVE HUMIDITY

   - Maximum : 55%
   - Minimum : 10%

3. Altitude : Not exceeding 100m (MSL)

1.4 Instructions to Bidders

1.4.1 All equipment and material shall be designed manufactured and tested in accordance with the latest applicable Indian Standard & IEC standards.

- The electrical installation shall meet the requirement of Indian Electricity Rules as amended up to date relevant IS code of practice and Indian Electricity act. In addition other rules of regulations applicable to the work shall be followed.

- The high tension Switchgear, distribution transformer, LT Switchgear & Its accessories offerd shall in general comply to the following Specifications as attached.

  a. Specification for 11kV Non extensible Breaker Panel
  b. Specification for Distribution Transformer
  c. Specification for LT system
  d. Specification for enclosure for package substation.

A. SPECIFICATION FOR 11 kV Non-Extensible Breaker Panel

1.5 Codes and Standards

1.5.1 The equipment shall comply with the requirements of latest revision of following standards issued by IEC/BIS (Bureau of Indian Standards), unless otherwise specified.

IEC 60694:	Common clause for High Voltage switchgear and low voltage switchgear.
IS 13118/IEC 62271-100	High Voltage alternating current circuit breakers.
IS 12729/IEC 62271-200	AC metal enclosed switchgear and control gear for rated voltages above 1kV and upto and including 52kV.
IEC 61330	High-Voltage/Low-Voltage prefabricated substation.
IS 9921/IEC 60129	Switches and earthing switches.
IS 9920/IEC 60265	Switches and disconnectors.
IEC 60420	Combined switch/disconnectors.
IEC 60420	High voltage fuses.
IS 2705/IEC 60185	Current Transformers.
IEC 60060	High voltage test procedures.
IEC 60529	Classification of degrees of protection for enclosures.

1.5.2 In case of imported equipment standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.

1.5.3 The equipment shall also conform to the provisions of Indian electricity rules and other statutory regulations currently in force in the country.

1.6 Design Criteria

1.6.1 The 11KV Non-Extensible with Metering (Incomer) shall be installed at Outdoor substation location. 11KV HT breaker (SF6) at incomer.

1.6.2 The Switchgear and component there of shall be capable of withstanding the mechanical and thermal stresses of short circuit listed in ratings and requirements clause without any damage or deterioration of the materials.

1.6.3 For continuous operation at specified ratings temperature rise of the various Switchgear components shall be limited to permissible values stipulated in the relevant standard and / or this specification.

1.6.4 The equipment offered shall be suitable for continuous satisfactory operation as per site condition specified else.

1.6.5 All the switchgears shall be suitable for retrofitting for automatic operations using SCADA / equivellent automation.

1.7 Specific Requirement

1.7.1 The requirement of 11KV, 21KA SF6 insulated Non-Ext. SF6 insulated HT Breaker Panel as under.

a. HT Breaker panel unit suitable for Indoor/Outdoor installation shall consist of the following.

i. One no unit with 11kV, 630 Amps SF6 / Vaccume Circuit Beaker , load breaking and fault breaking type fitted with three 400 Amps continuously rated SF6 insulated bus bar along with CT & PT. It shall have arrangement for terminating up to 400 mm² 11KV, 3C XLPE (E) cables.

ii. Providing **Reusable boot** for terminations (3X3 nos.)

1.7.2 System:

The system network is 11000 Volts, 3 phase 3 wires 50 cycles with neutral solidly grounded. The voltage and frequency are subject to variation as per statutory limits governed by Indian Electricity Rules 1956 with latest amendments in force.

a. **GENERAL FINISH:**

The equipment should be totally enclosed, metal clad, vermin and dust proof suitable for tropical climate use as detailed. The body of the HT Panel Unit should be of Totally weatherproof and should be rust free. (The details of the construction and material specification and the expected life span of the body shall be specifically mentioned)

B. **PAINTING:**

The surface of all metallic parts shall be thoroughly cleaned, scrapped and degreased preferably by shot blasting or any other treatment. The exterior surface shall be given two coats of rust resisting red oxide primer conforming to IS 2074:1992 and final two coats of weather resisting battleship grey enamel paint or RAL 9002. The paint shall withstand the operating conditions described above and equipment shall not show any sign of the rust formation.

C. **RATING:**

The bus bar shall have continuous rating of 400 Amps.
All connection including band joints for bus bars etc shall be of ample cross section to cater the rated load current continuously and shall be suitable for short time rating of 21 KA for 1 second.

1.8 Breaking and Making Capacity

The SF6/Vacuum circuit breaker shall be capable of having rupturing capacity of 350 MVA symmetrical at 11000 Volts three phase. Symmetrical breaking capacity shall be 21 KA and the making capacity of 52.5 KA at 11000 Volts. The isolators shall be capable for breaking rated full load current and shall have fault making capacity of 52.5 KA peak. In case of asymmetrical breaking capacity, DC component shall be indicated by bidder in the offer.

1.8.1 TYPE OF EQUIPMENT:

a. The equipment shall be compact, totally enclosed in a self-contained self-supporting, gas tight compartment, mounted on base frame or channels. The assembly shall be equipped with common power bus bars, load break Switches and SF6 circuit breakers as specified in specific requirement as above. All High voltage parts should be totally enclosed in an SF6 environment.

The free-standing metal housing shall be designed to withstand internal pressure and external mechanical loads without distortion. Where required the SF6 gas insulated Switchgear housing shall have an over pressure relief device vented to the rear side of the equipment. An operating mimic diagram shall be provided on the front side of RMU. Each unit shall be provided with lifting facility of proven design for easy handling.

Breaker ON-OFF, Earth, & 'SF6 gas pressure low' indication etc. shall be provided.

Handle operated 'spring assisted' or 'spring charged' mechanical operation shall be provided.

SF6 Insulation: Switchgear housing shall be completely gas tight.

A manometer should be provided to indicate the healthy state of SF6 gas pressure inside the tank. SF6 gas pressure inside the tank shall not be more than 1 bar (g) at 20 Deg Centigrade.

b. **BUSBARS:** The bus bar shall be SF6 insulated type. The cross sectional area of the copper bus bar and jointing accessories shall be specified by the vendor / stated in the tender.

1.8.2 SF6 Circuit Breaker

a) Breaker Panel shall consist of 11KV, 400/630 Amps SF6 VCB (for Controlling transformer) load breaking and fault breaking type fitted with three 400 Amps continuously rated SF6 gas insulated bus bars and arrangement for cable to the primary side of the transformer.

b) The circuit breaker shall be motor operated and shall have a provision for remote tripping in future.

c) The operating mechanism shall be direct hand operated trip free with a mechanically operated indicator, positively coupled to the operating mechanism to indicate whether the breaker is in the closed or in the open position.

d) Each circuit breaker shall be fitted with motor operated with spring assisted/charged mechanism having three positions, "ON", "OFF" and "EARTH" provided with pad locking facility. All operating handles shall be located on the front panel of the ring main unit.

e) Voltage Indication: There should be arrangement to check whether the cable connecting to the breaker is live or not.

f) The tee-off unit shall be provided with accessories for tripping such as CT operated series trip coils for over current and earth fault protection.

g) Breaker shall be provided with a shunt trip coil suitable for 230V AC supply.

h) Current Transformer: The Ratio of the CTs shall be suitable for Controlling transformer as specified in purchase enquiry. The VA Burden of the CTs shall be sufficient to supply the energy required by the relay for normal operation and tripping of the circuit breaker.

i) Protection System: The protection system should be provided with self powered IDMT protection relays which requires no external power source or batteries for tripping. Relay shall be static type with three over current & single earth fault element. The overcurrent element should follow a fuse replica or extremely inverse curve and earth fault element should be definite time type. The protection system should be suitable for protecting transformers of rated power upto 990kVA.

j) The technical particulars of the Circuit Breaker are

a)	Construction	SF6 Single Break
b)	Current capacity	400/630A
c)	Making capacity	52.5 kA
d)	Short time rating	21kA for 3 Sec.
e)	Impulse flashovers withstand voltage	75kV peak
f)	Power frequency withstand voltage	28kV (rms)
g)	Current Transformer	11KV tape wound
i)	CT ratio	50 /5A
ii)	Over current factor	To correspond to breaking capacity
iii	Class of accuracy	Class X suitable for self-powered relay
iv)	Impulse flash over withstand voltage	75kV (peak)

v)	Power frequency withstand voltage	28kV (rms)
h)	Protection	Self-powered IDMT Protection relays, no external AC/DC aux power required for tripping. Static type, with 3 over current and single earth fault elements. The over current element should follow a fuse replica or extremely inverse curve, and earth fault element should be definite time type. For Outgoing breaker protection system should be suitable for protecting transformers of 400 KVA.
i)	The circuit breakers shall be provided with interlocked earth switch	
j)	Three Nos. CT.s on the bushings incase of cable mounted ring CT's adequate insulation shall be provided to the full rated voltage of the Breaker, including impulse withstand voltage.	

1.9 Operation And Interlocking

1.9.1 All operations shall be from front of the equipment via spring assisted mechanism. The SF6 CB should be provided with a series trip coil for tripping. It shall be possible to operate the Switches and circuit breaker manually and spring assisted mechanism shall ensure speed of operation of Switches.

1.9.2 Operation handle shall be considered as part of the unit and should be provided with each Panel.

1.9.3 Breaker and earthing Switches shall be fully interlocked to ensure that operation is carried out in correct sequence. Movement of operating handle against interlock shall not by any means originate, store or activate the energy mechanisms. Padlocking facility shall be provided for operation of load Switch and earthing Switch. Safety of operation shall be ensured by interlocks.

1.9.4 Simultaneously closing of the main Switch and earth Switch. This interlock shall be integral part of the operating mechanism.

1.9.5 SF6 breaker operating mechanisms shall be totally enclosed and self lubricating type. The manually operated handle shall be mounted in front of the isolators and so designed that the operation is complete by one movement without any undue stain on the operator.

1.9.6 All mechanical interlock shall be robust so as not to give any way during normal operation.

1.9.7 The tripping of breaker unit should be provided with push button.

1.10 Earthing Arrangement

1.10.1 It shall be easily possible to test cables of Isolators without opening cable compartment covers & without disconnecting cables.

1.10.2 Equipment earthing of copper strips of adequate size shall be provided.

1.11 Cable Boxes

1.11.1 The isolators and SF6 CB shall be provided with suitable cable boxes for connection 3 core, 11KV XLPE cables of size up to 400 mm^2 approaching vertical from below. The cable boxes shall be so located at convenient height to facilitate easy cable jointing work.

1.11.2 The design of the cable box shall be such that any type of jointing methods such as heat shrinkable/push on type/cold shrinkable type termination's can be adopted.

1.11.3 Earthing: All ring main units shall have a special earth bar with a sectional area of not less than 100 mm^2 run along the whole of metal enclosed Switch structure, each end being connected to the main earthing system where metal cases are used on instruments these shall be connected to this bar by copper conductors of not less than 16 mm^2 section.

1.11.4 All foundation bolts, nuts and washers necessary for installation shall be supplied by the manufacturer.

1.11.5 Removable eye bolts shall be provided to facilitate the handling of RMU/tee-off unit/SF6 isolators.

1.11.6 Labels: All Breakers shall be clearly labelled as required indicating where necessary their purpose and "ON" and "OFF" lettered on brass, ivory, enamel iron or other suitable materials.

1.12 Tests

Each type of H.V. Switchgear shall be completely assembled, wired, adjusted and tested at the factory ssas per the relevant standards and during manufacture and on completion.

1.12.1 Routine Test

The tests shall be carried out in accordance with IEC 62271-200 include but not necessarily limited to the following:

i. Withstand voltage at Power Frequency for all current carrying parts including wiring
ii. Measurement of resistance of the main circuit
iii. Gas Leakage test
iv. Withstand voltage on auxiliary circuits
v. Operation of functional locks, interlocks, signaling devices and auxiliary devices
vi. Suitability and correct operation of protections, Control instruments and electrical connections of the circuit breaker operating mechanism.
vii. Verification of wiring
viii. Visual Inspection

Routine test shall be carried out on all equipment such as circuit breakers, current transformers, relays, meter etc. as per relevant standards.

1.12.2 Type Test

The following type test should have been conducted on HT Breaker Unit inline with IEC 62271-200.

i. Short time current test on main circuits.

ii. Short time current test on earthing circuit.
iii. No load operation and mechanical endurance test.
iv. Impulse withstand test 75kV rms (1 min.)
v. Temp rise test.

Type test certificate of Breaker unit, if so desired by the customer, shall be furnished; otherwise the equipment shall have to be type tested, free of charge, to prove the design.

B. SPECIFICATION FOR DISTRIBUTION TRANSFORMER

The bidder has to quote for the following types of distribution transformers.

Specification for 11/0.415 dry type hermetically sealed Distribution Transformer

1.13 General Information

All equipment and material shall be designed manufactured and tested in accordance with the latest applicable Indian Standard, IEC standard and CBIP manuals except where modified and / or supplemented by this specification.

The electrical installation shall meet the requirement of Indian Electricity Rules as amended up to date, relevant IS code of practice and Indian electricity act. In addition, other rules of regulations applicable to the work shall be followed.

The Transformer offered shall in general comply with the latest issues including amendments of the following Indian standards.

1.14 Code and Standards

The transformer shall comply with the latest edition of the following and other relevant Indian Standards / Manual:

IS 335;	Insulating oil
IS 1271:	Thermal evaluation and classification of electrical insulation.
IS 2026:	Power Transformers
IS 2099:	Bushing for alternative voltages above 1000V
IS 2705:	Current transformer
IS 3347:	Dimension for porcelain transformer bushings.
IS 3637:	Gas operated relays
IS 3639:	Fitting and accessories for power transformers
IS 4201:	Application guide for CTs
IS 6600:	Guide for loading of oil immersed transformer
IS 8478:	Application guide for ON load tap changers
IS 8468:	On load tap changers
IS 10028:	Code practice for selection, installation and Maintenance of transformer
IS 13947:	LV Switchgear and Control gear – Part – I General rules CBIP Manual on transformers
IS 2074:	Ready mixed paint, air drying red oxide,zinc chrome priming
IS 5:	Color of ready mix paint
IEC 76:	Power transformer
IEC 76.2 or IEC IEC-76-1 or IEC 726 or IS:2026(All Parts)	Temperature limits
IEC-298, or IEC 466	High voltage Switch gear and Control gear

IEC-947-1, IEC-439-1	Low voltage Switch gear and Control gear
IS:1180 IS:2026	For distribution transformers
IEC-550 (151):1978	SEV Chapter 151 Electro magnitude devices.
IS:1885	
IEC-60-1:1989	High voltage test Technique Part-I.
IS:2017 Part I	General definition and test requirements.

IEC-68-2-62:1991: Environmental testing – part 2, tests impact amendment 1(1993)

IEC-71-2:1976	Insulation co-ordination Part 2 Application guide
IS:3716	
IEC:76-1:1993	Power transformer Part I general
IS:2026 (Part I)	
IEC 76-2:1993	Power transformer Part 2 temperature rise.
IEC 76-5, 1976	Power transformer Part 5 ability to withstand short circuit test
IEC:243-1,1988:	Methods of tests for Electric strength of solid insulating
IS:258-1	Material Part – I tests and power frequencies.
IEC:354:1991:	Loading guide for oil immersed power transformer.
IS:6600	

IEC:551:1987: Determination of transformer and reactor sound level.
IS:13964

IS:2932:	Enamel synthetic, exterior a) under coating b)Finishing

IS:3347: Dimension of porcelain transformer bushing for use in very heavily polluted atmosphere

Indian Electricity Rules: 1956
Indian Electricity Act: 1910
The Electricity Act: 2003

Transformer shall also conform to the provisions of the latest revisions of the Indian Electricity rules and any other statutory regulations currently in force as per standards.

1.15 Design Criteria

11KV/ 415-volt distribution transformer shall be a part of packaged substation which will be housed in the enclosure.

The transformers shall be installed and operating in hot, humid tropical atmosphere. All equipment accessories and wiring shall be provided with finish to with stand tropical conditions and prevent fungus growth.

The transformers shall be capable of continuous operation of rated output under the operating conditions of voltage and frequency variations as per statutory limits governed by relevant Indian Standard and Indian Electricity Rules, 1956 / IEC with latest amendments in force.

The transformer shall conform to best engineering practice.

The transformers shall be capable of withstanding the short circuit stresses due to terminal fault between phase to phase and phase to ground on one winding with full voltage maintained on the other windings for a minimum period of three seconds.

The transformers shall be free from annoying hum or vibration. The design shall be such as not to cause any undesirable interference with radio or communication circuits.

The equipment offered shall be suitable for continuous satisfactory operation at stated site.

1.16 SPECIFIC REQUIREMENT:

1.16.1 **Requirement:** 11000/415 Volt hermetically sealed Dry Type **500 KVA** ONAN cooled double wound, core type suitable for packaged substation housed in an enclosure.

1.16.2 **Voltage Ratio:** No load voltage 11000/415 volts within tolerance as stipulated in IS: 2026.

1.16.3 **Rating:** The transformer shall have a continuous rating as specified at any of the specified tapping position and with the maximum temperature rise specified. The rated KVA shall be the product of the rated voltage in kV, the corresponding rated current and the phase factor 1.732.
System: 11000 volts A.C. supply, on H.V. side and 415 Volts on L.V. side with variations, as per statutory variation governed by relevant Indian Standards and Indian Electricity Rules, 1956 / IEC with latest amendments in force. The Star point / L.V. neutral is earthed solidly at each transformer substation.

1.16.4 **Temperature Rise:** The **maximum temperature rise** at the specified maximum continuous output shall not exceed 45°C by thermometer in the hottest portion of the oil or 50°C measured by resistance of winding above ambient temperature.

1.16.5 **Type of Load:** The transformer shall be suitable for carrying load within temperature rise indicated in the Indian Standard specification IS: 6600 'Guide for loading of oil immersed Transformer'.

1.16.6 **Overloads:** The transformers shall be suitable for carrying overload within temperature rise indicated in IS: 6600 'Guide for Loading of oil immersed Transformer'.

1.16.7 **Connections:** H.V. Delta and L.V Star connected with neutral brought out on the secondary side for connection to earth; Vector group DYn11 of IS:2026.

1.16.8 **Tapping:** Each transformer shall be provided with **Rotary type tap Switch** so as to provided for a voltage adjustment on H.V. from **+10%** to **–10%** of rated voltage of 11000 volts in 8 equal steps (9 position) to obtain rated voltage of 415 volts on LV side.

1.16.9 The tapping shall be provided for following voltage ratios at no load.

Tap position	1	2	3	4	5	6	7	8	9
HV	12100	11825	11550	11275	11000	10725	10450	10175	9900
LV	415	415	415	415	415	415	415	415	415

1.17 Tank

The transformer tank and cover shall be fabricated from robust M.S. plate steel without pitting and shall have adequate thickness, with external cooling tubes or radiators. The tank and cover shall be of welded construction. The tank is hermetically sealed and there should not any leakage from any joints. All seams shall be welded and where practicable they shall be double welded. All edges shall be double welded. The tank wall shall be reinforced by stiffener to ensure rigidity, so that it can withstand the stresses without any deformation

(a) Mechanical shock during transportation
(b) oil filling by vacuum.

All removable covers shall be provided with weatherproof, hot oil resistant, resilient gaskets. The design shall be such as to prevent any leakage of water into or oil from the tank.

The tank shall be subjected to a pressure test of 0.35 kg/cm^2 with hot oil for 12 hours when the transformer is complete with all fittings. During the test average oil temperature shall be maintained at 45°C above Ambient temperature throughout test period by circulating suitable current in HV winding and short circuiting L.V. winding. There shall be no leakage of oil during or after the test. Also there shall be no deflection at all when the pressure is removed. The purchaser's representative may be present during these tests for which advance intimation shall be given and **test Certificate for this test shall be produced by the supplier in triplicate before dispatching the units**.

Air release plugs shall be provided on main tank top cover to cover entire area suitably.

a) Inspection covers shall be provided to facilitate individual inspection, without lifting the tank cover, for the following:
b) Connection of primary winding to cable box/disconnection chamber bushings.
c) Connection of secondary winding to cable box/disconnection chamber bushings.
d) Main tank center for core/winding inspection.

1.18 **Oil:**. The Supplier shall furnish the relevant technical particulars and test certificates of the oil supplied. An additional 10% of the total quantity of oil required shall be supplied loose along with the transformer.

1.18.1 **Clamping of leads:** All leads from the coils to the terminals shall be suitably clamped to prevent snagging and fouling with other parts and the tank.

1.18.2 **Phase Marking:** Phase markings as per IS: 2026 punched on small non-corrosion metallic tags shall be permanently fixed for H.V. just below the cable box or on some suitable removable part of the tank and above L.V. Bushings. Phase markings tags shall be properly fixed with proper alignment.

1.19 Core and Coil

1.19.1 The core shall be constructed from high grade, cold rolled, non-ageing, low loss, high permeability, grain oriented, cold-rolled grain oriented silicon steel laminations. The transformer shall be so designed as to have minimum humming noise. The percentage harmonic potentials with the maximum flux density under any conditions shall be such that capacitors connected in the system shall not be overloaded.

1.19.2 The coils shall be manufactured from electrolytic copper conductor and fully insulated for rated voltage.

1.19.3 Insulating material shall be of proven design. The insulating materials shall be **class "A" or above** specified as per IS: 1271. Coils shall be so insulated that impulse and power frequency voltage stresses are minimum.

1.19.4 Transformers may be connected at the end of 11 kV and 0.415 kV feeders, in a lightning prevalent area.

1.19.5 The coil assembly shall be supported suitably between adjacent sections by insulating spaces & barriers. Brazing shall be arranged to ensure a free circulation of the coil & to reduce the hot spot of the winding.

1.19.6 All leads from the windings to the terminal board and bushings shall be rigidly supported to prevent injury from vibration or short circuit stresses. Guide tube shall be used wherever practicable.

1.19.7 The core and coil assembly shall be securely fixed in position so that no shifting or deformation occurs during movement of transformer. The core and coil assembly shall be capable of withstanding without injury, the thermal and mechanical effects of short circuit at the terminals of any winding as per IS:2026.

Loss Table(Bidder to specify as GTP) (Must Comply to Latest ECBC standard)

Transformer(Dry Type)	50% Load	100% Load
500 KVA	1510 watt	4300 watt

There should be no positive tolerance for the losses.
The losses are to be used for evaluation on the basis of loss capitalization.

1.19.8 Efficiency should be as per IS 1180 level – 2

1.20 RATINGS of TRANSFORMER (SUMMERY) :

Sr. no.	Application	500 Kva
1	Service	Outdoor in an Enclosure, Step down
2	Type	Dry type Hermitically sealed
3	Cooling system	ONAN
4	No. of Phases	3
5	Rated output (KVA) With ONAN cooling	500 KVA
6	Rated voltage in KV (Line to Line	HV-11 kV LV-0.415 kV
7	Rated frequency	50 Hz
8	Temperature rise above 50°C	
A	In winding by resistance	50°C or above
B	In Oil by thermometer	40°C or above
9	Guaranteed losses at 75°C and at normal tap position without any tolerance	**500 KVA**
A	No Load loss (W)	VTS (Vendor To Specify)
B	Full Load loss (W)	VTS
C	Total loss (W)	VTS
10	Insulation level	
A	H.V. Power Freq. KV rms	28 kV
B	H.V. (kVpeak) Impulse	75 kV
C	L.V. (kV)	-
11	Vector Group	Dyn11
12	Parallel operation	Yes in future, if required
13	Type of taps provided	Off Load full capacity
A	Taps provided on	H.V. winding
B	Range of taps	+10% to -10% in steps of 2.5% (8 steps, 9 position)

Sr. no.	Application	500 Kva
C	Method of Tap Change control	Rotary Switch
D	Manual load	Yes 'Off Circuit'
14	Percentage impedance at 75 Deg. C	VTS
15	System earthing	
A	H.V.	Solidly earthed
B	L.V.	Solidly earthed
16	Terminal arrangement	
A	H.V.	VTS
B	L.V.	VTS.
C	L.V. Neutral	VTS
17	Transformer-bushing voltage class a) H.V. (kV) b) L.V. (kV)	 12 kV class 1.1kV class
18	System fault level a) H.V. side b) L.V. side	 350 MVA (11 kV), -
19	Short circuit withstand capability duration	3 sec.

1.21 Fittings & Accessories For Tank Transformer :

1.21.1 The following accessories shall be provided for 11 kV/0.415 kV, 500 kVA distribution transformer.

1.21.2 Two earthing terminals with copper lugs. The lugs shall be provided in such a way that they shall not obstruct the movements of rollers. The earthing continuity for all the connected equipments shall be properly done.

1.21.3 Two lifting lugs for complete transformer as well as enclosure.

1.21.4 Off circuit tapping switch shall be rotary type, 3 pole gang operated, top mounting draw out type only. Tap Switch shall be provided with externally operating hand wheel handle with indicator and locking device, with direction changing facility and locking arrangement. Bidders shall submit with the bid, technical catalogue for the off load tap switch for Purchaser's approval.

1.21.5 **Rating plate and diagram plate** of durable non-corroding metal giving information as required under IEC 76. Rating plate shall also include Transformer **Actual %Z, No-Load Loss & Full-Load Loss at 75°C** along with details like Purchase Order Number, date. The name plate marking shall be done with fluorescent colour. Each equipment shall carry individual name-plate with proper instructions & affixed with screws.

1.21.6 Four plain rollers fitting so that the transformer can suitably moved in any direction along with roller direction changing and locking facility shall be provided.

1.21.7 1 Nos of winding temperature indicator and controller.

1.21.8 Skid with Haulage lugs.

1.21.9 Instructions & affixed with screws.

a. 2 Nos. of Lifting lugs on top tank lid for lifting the complete transformer.
b. Rating & diagram plate of stainless steel.
c. Transformer tank earthing should be connected to the earth bus bar of the USS
d. All terminals of HV & Lv side side should be properly marked.
e. Off circuit tap changer bridge type for voltage variation on HV side
f. preferably with 9 taps in steps of 2.5%.
g. 3Nos. of HV bushings, Porcelain type.
h. 4Nos. of LV bushings, Porcelain type.
i. Thermometer pocket on top of the tank lid for dial type thermometer (OTI) (WTI)
j. with alarm & trip contact..

TESTS for Oil Type Distribution Transformer

ROUTINE TESTS (As per IS 2026, clause 16.1.2)

The following tests are to be carried out as per IS 2026, clause 13.2.
i. Measurement of winding resistance
ii. Measurement of voltage ratio & check the voltage vector relationship
iii. Measurement of impedance voltage (principal tapping), short circuit impedance & load loss all shall be corrected to a temperature of 75 °C
iv. Measurement of no load loss and current
v. Separate source withstand voltage
vi. Induced over voltage withstand
vii. Dielectric Test of Oil

TYPE TESTS (As per IS 2026, clause 16.1.1)

i. Measurement of winding resistance
ii. Measurement of voltage ratio & check the voltage vector relationship
iii. Measurement of impedance voltage (principal tapping), short circuit impedance & load loss all shall be corrected to a temperature of 75 °C
iv. Measurement of no load loss and current
v. Separate source withstand voltage
vi. Induced over voltage withstand
vii. Dielectric Test of Oil

SPECIAL ACCEPTANCE TEST (As per IS 2026, clause 16.1.3)

i. Short Circuit test
ii. Acoustic Noise Level Test
iii. Oil Leakage Test by application of pressure

MISCELLANEOUS

a) All components parts and auxiliary equipment such as bushings, tap changing gear, etc. shall be routine tested as per relevant Indian Standards.

b) The manufacturer shall have the necessary laboratory grade instruments and equipment for carrying out all routine and type tests and get these calibrated at frequent intervals.

c) The transformers (including tap change gear) shall be capable of withstanding without damage the thermal and mechanical effects of short circuits at the terminals of any winding or the periods as provided by latest IS:2026/Part1/1977. The manufacturer shall supply the calculation for short circuits in case required by purchaser.

SPECIFICATION FOR LT SYSTEM

LT compartment shall be suitable to house following equipment,

- Bus bar connection from transformer to LT MCCB
- Provision for Tri vector meter for Incomer.
- CT for metering
- CT and voltage connection wiring for Tri vector meter

Auxiliary supply

3 phases with neutral, 415V AC supply shall be tapped from main bus bar after the ACB for supply to lighting of the substation.

2.0 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 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.

2.3 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

2.4 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 rating (rms) for 1 sec. (Icw)	:	As per BOQ
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
D	**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 bars	:	As Per SLD
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

2.5 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.

2.6 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.

2.7 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.

2.8 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.

2.9 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.

2.10 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.

2.11 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 labelled with reference number and/or letter of their function. Labels for feeder panel designation shall be fixed on the front side of respective panels.

2.12 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.

2.13 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 -

- Appearance and construction.
- Dimensions, mounting details etc.
- Feeder arrangement and feeder details.
- Door alignment, gaskets etc.
- Alignment of switch drive and handle.

2.14 Tests:

The following tests shall be carried out:

2.14.1 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.

2.14.2 High Voltage Power Frequency Test:

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

- between all three phases and earth.
- between the phases.
- between phases and neutral.

2.14.3 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.

2.15 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

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

2.16 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:

- Nos. of installation and operation manual
- Nos. of all as built drawings.
- Nos. of operating handles.
- Reproducible drawings on Compact Disc.

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

2.17 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.

2.18 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 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

2.19 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 hooter
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.

2.20 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.

2.21 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.

2.22 Tests:

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

- Test for output and capacitance.
- Voltage test between terminal and container (for capacitor unit).
- Voltage test between terminal and earth (for capacitor bank).
- Insulation resistance test.
- HV test
- 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.

2.23 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:

- Electrical and mechanical operations of circuit breaker
- Functional test of CB
- Insulation Resistance.
- Testing of relays/release
- Checking of all electrical connections, electrical and mechanical interlocks.
- Inter changeability of breakers as desired by Engineer-in-Charge at site.

2.24 Drawings:

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

C. AMF PANEL

2.25 Construction Features:

The construction features shall generally comply with L.T Panel specifications

2.26 AMF Panel Components:

The AMF panel shall be provided as per Drawing along with all other details as Required Battery charging arrangement with trickle & boost mode, DC ammeter & Voltmeter etc. – 1 nos. (1no. for Each DG set starting batteries)

Microprocessor based AMF controller comprising of, but not limited to, following:

- Mains supply failure monitor (voltage sensor).
- Supply failure timer.
- Restoration timer.
- Control unit incorporating 3 impulse automatic engine start/stop & failure to start lockout.
- Impulse counter with locking & reset facility.

AMF Panel control supply will be 110 V DC or as specified in the BOQ and is to be tapped from 110 V DC system of adjoining substation and suitable power cable & control cables to be involved in the scope.

- Protection:
- Field failure relay
- Reverse power relay
- Earth fault relay

2.27 Metering:

2 Nos. 0-500V, 144 sq.mm. voltmeter with 3 way & off selector switches.
1 No. static energy meter
1 No. energy analyzer on load side for monitoring voltage, current, KW, KWh, pf. Frequency etc.

2.28 Push button & switches.

Auto / manual / test mode selector switch
Emergency stop push button.
Hooter accept push button.

Cluster LED indication lamps, 110 V DC.
RYB – Mains ON.
RYB- DG Set ON.
Load on Mains.
Load on DG Set.
DG Set on Test mode.
Trip Circuit Healthy.

12 window Annunciation panel – 110 V DC: -
Engine fails to start.
High water temperature.
Low lub oil pressure.
Engine over speed.
Generator under voltage.
Generator over voltage.
Generator under frequency.
Generator over frequency.
Generator over load.
Generator loss of excitation.
Battery Charger fail.
Canopy temperature high.
Hooter with 110 V DC supply.
Necessary auxiliary contactors for contact multiplication.
Necessary MCB's for supply to canopy lighting, battery charger etc.
The components which are not indicated above, but are required for the functioning of AMF Panel shall be included in the scope of work.

2.29 Operational logic:

The automatic Mains Failure panel should be able to run the DG set in following modes:

- Auto Mode
- Test Mode
- Manual Mode.

Auto Mode:

If the Mains are absent or Mains fails, the controller starts the engine after a programmable delay and transfers the load to the generating set. If the Mains restores, the load is connected back to the Mains, after a programmable delay and the generating set stops after cooling down time.

In the auto mode, when the "Mains supply" fails the 'Mains supply failure monitor' (Voltage sensing) & mains failure timer operates after a preset time of approx. 10 seconds (adjustable), this activates the 3 impulse auto engine start / stop control unit. This control unit shall give these starting impulses with an interval of 1-5 seconds. If the engine starts with the first impulse, the control unit should be shut off and if not, the control unit should give further two impulses during which time, if the engine does not start, the control unit shuts off the start signal & activate the audio visual alarm for 'set fails to start'.

On starting of the engine, the alternator ACB should close automatically after sensing the proper voltage level, frequency etc. If at any time the voltage & frequency is not as per the required conditions, the alternator ACB should automatically trip, disconnecting the DG set from the load.

When the Main supply is restored, the 'restoration timer' should operate and after the pre-set time, the load should automatically get transferred to the mains (transfer time to be selectable) and the alternator should shut down thereafter with adjustable (0 to 5 min.) time delay.

Test Mode:

By operating the selector switch in 'Test' mode, the conditions of Mains Failure shall be simulated as per point a.i above.

Engine shall build up voltage but the set shall not take load by closing alternator ACB.

During the process of testing, if the mains supply fails, the alternator should be able to feed the load through auto closing of the alternator ACB.

Bringing the mode selector to 'Auto' position shall shut down the set as per point a.iii above, provided mains supply is ON. If the mains supply is not available at that time, the alternator shall take the load as in point b. iii above.

Manual Mode:

In a manual mode, it shall be feasible to start up DG set by operator on pressing the 'Start' push button.

Three attempt starting facility shall be operative for the start-up function.

Alternator ACB closing and trip operations shall also be through operator by pressing appropriate button on the ACB and the closure shall be feasible only after alternator has built up full voltage. If the load is already on mains, pressure on close button will be ineffective.
Engine shut down, otherwise due to faults, shall be manual by pressing a 'stop' push button.

2.30 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 -

- Appearance and construction.
- Dimensions, mounting details etc.
- Feeder arrangement and feeder details.
- Door alignment, gaskets etc.
- Alignment of switch drive and handle.

2.31 Tests :

The following tests shall be carried out:

2.31.1 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.

2.31.2 High Voltage Power Frequency Test:

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

- between all three phases and earth.
- between the phases.
- between phases and neutral.

2.31.3 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.

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

2.32 Installation:

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
- Functional test of CB
- Insulation Resistance.

- Testing of relays/release
- Checking of all electrical connections, electrical and mechanical interlocks.
- Interchangeability of breakers as desired by Engineer-in-Charge at site.

2.33 Drawings:

The following are to be furnished and got approved from the department by the successful bidder, before taking up manufacturing:

- G.A. diagram of AMF panel.
- Schematic diagram of AMF Panel and control circuit.
- Control cable schedule between DG set & AMF Panel.

D. DG SYNCHRONIZATION PANEL

2.34 Scope:

This specification covers the technical requirements of design, manufacture, testing at manufacturer's works, supply, installation, testing and commissioning of DG synchronization panel suitable for automatic start of DG sets, automatic synchronization, automatic load sensing, automatic load sharing, shut down of DG sets as per load sensed & programmed logic etc. for DG sets.

The DG synchronization panel shall comply with general Panel construction specification indicated in Section 1 of this document.

2.35 DG Synchronization Panel Components:

Programmable Logic Controller (PLC).
1 nos. of 415V,800A, FP, EDO ACB, DG incomer breakers.
415V, 800A, TPN tinned Al bus bar.
1 nos. of 415V, 800A, FP, EDO ACB, outgoing breakers.
DG protection relays & annunciation Panel for each DG incomer feeder.
The DG Synchronization Panel shall be complete with all Auxiliary Relays, timers, Contactors, Programmable Logic Controller, control wiring with 1.5 sq. mm PVC insulated 1100 V grade copper conductor wires, interconnections etc. as required as per operation logic indicated in the specifications and OEM recommendations.

2.36 Programmable Logic Controller (PLC):-

The entire operation of the DG power generation system will be controlled automatically through a PLC. The PLCs shall be state of art equipment using latest technology and of most rugged and reliable design. Since they shall be operating in the harsh & unfriendly environment of DG room, they will be suitable to operate trouble free in those conditions. The chosen equipment should be able to withstand high temperature, humidity and voltage fluctuations, thus making it suitable for the operating conditions described above.

The Automatic PLC System basically shall consist of:

- Main processor unit.
- Power supply for unit
- Mounting chassis.
- Digital input module 32 channel.
- Digital output module 32 channel.

- EEPROM for CPU.
- Analog input module 8 channel.
- Window based graphic software.
- Package with PC to PLC Communication.

2.37 Functions / features of plc system:

In general terms the following will be the functions of PLC:
The system will directly accept CT & PT signals for electrical parameters monitoring and control.
Depending upon the load requirement, starting and stopping of DG sets.

Automatic selection of DG for stopping / tripping as per load & pre-programmed logic.

Monitoring of electrical parameter per DG, Voltage, Frequency, reactive load, active load, energy produced, voltage error (%), frequency error and phase angle error etc.
Status and control of outgoing breakers.

Backup protection electrical / mechanical by time delay tripping of DG sets.

Data acquisition system will have incorporated with the system for the purpose of recording and display of all important and critical parameters of the engine, alternator and system as such in totality.

"B" check alarm after each DG complete 300 hours of running for proper maintenance.

Tripping of less priority loads in the plant in case of under frequency of bus both in isolation as well as synchronized mode.

PLC system shall have provision to test the DG in auto mode without closing the breaker to do the routine electrical / mechanical testing of set without interruption of power generation.

Operation of DG sets shall be monitored and controlled by a Programmable Logic Controller (PLC) which shall actuate and control Auto Mains Failure, Auto Changeover / Interlocking and Auto Load Management functions along with fault annunciation, alternator control and protection. The PLC Panel shall be provided with a total manual over-ride. The PLC shall ensure providing suitable software interlocks, in addition to hard wired interlocks, to achieve the sequence of operation indicated in the specifications.

PLC shall be of state-of-art technology, microprocessor based, fully programmable, modular in Construction with DIN Rail mounting facility. It should be able to perform functions like boolean logic, bracked operation, result assignment, setting/resetting (latching/unlatching), counter and timer functions, load transfer, comparison and jump operation, block calls, special function, logical word gating & arithmetic operations.

PLC or Controller shall have Microprocessor (CPU) with EPROM/EEPROM with a minimum memory size of 8K bytes which will be non-volatile memory & shall be modular & plug in type. The CPU will have a receptacle for such memory sub-module (EPROM/EEPROM) for on- or – Off – line loading for program security. In addition, the CPU contains:

As internal power supply (24V / 9V DC)
Also internal power supply for input / output Modules.

An internal programme memory (RAM) with battery back up to save the contents of the RAM in the event of power failure. RAM memory size should be 4K bytes & above.

A programmer port Built in "COPY" function to save and transfer use programme without a programmer. The programme transfer would be from memory sub module to internal RAM of CPU.

Application program modules like Analog Input/output Modules. Digital Input/output modules for programme algorithms specified. The modules should be Modular plug-in type with in-built LEDs for status indication of each Input/Output. The output modules should be adequate ratings for driving various loads like cranking, fuel Solenoid, ACB closing & trip Coils etc. either directly or through interposing relays.

Execution time of the CPU should be in the range of 2ms to 7ms for 1K binary statements.

The PLC shall have high degree of accuracy for Analog Inputs/Outputs. The PLC shall be suitable for operation in ambient weather conditions of 0 to 50oC & 15 to 95% humidity.

The offer for the system shall be complete in all respect, clearly specifying the bill of materials, make of various components selected number of Analog & Digital Inputs/Outputs considered in the offer along with complete technical details of the PLC selected like RAM/EPROM/EEPROM Memory size, execution time, I/O capacity, no of programmable timers/counters, internal flags etc.

The system supplier will supply built drawing along with trouble shooting and operation and maintenance guidelines.

2.38 Sequence of system operation:

Auto Mode System Operation:

While the normal mains supply is healthy, the DG set shall be at rest and the load shall be supplied by the mains.

The PLC system/ Synchronization relay/ DG controller shall monitor supply voltage on each phase through voltage transducers at the output of the incomer breakers in the Main LT Panel. When the mains supply fails completely or falls below set value (variable between 80% to 95% of the nominal value) on any phase, the monitor module shall initiate start-up of diesel engine. To avoid initiation due to momentary dips or system disturbance, a time delay adjustable between 0.5 to 5 seconds (adjustable) shall be incorporated in the startup initiation.

A three-attempt starting facility shall be provided with the sequence 6 seconds ON- 5 seconds OFF-6 seconds ON- 5 seconds OFF and 6 seconds ON. At the end of the third attempt if the engine has not been already started and built up voltage, engine shall be locked out for start. A master timer shall be provided for the function. An audio visual alarm shall be given.

Suitable adjustable timers shall be incorporated which shall make it feasible to vary independently ON-OFF setting periods from 1-10 seconds. If the alternator does not build up voltage after the first or any start, as may be, further starting attempt shall not be made and the starting facility shall be reset.

Once engine has built up voltage, the DG set which achieves the rated voltage built up first, becomes the master & its voltage and frequency is reference for other DG sets to be synchronized with this master DG set.

The DG sets are synchronized by their own engine controllers communicating with other engine controllers through proprietary protocol/ or by synchronization relay. Once the DG sets are synchronized, which is monitored through power monitors at the DG incoming breakers by PLC, the outgoing breakers of synchronization panel is closed by PLC.

System provided in the PLC Panel shall check and ensure that all the engine auxiliaries like lub oil pump are running and healthy. In case of any fault in engine auxiliaries, the system shall automatically stop the DG set and an audio visual alarm shall be given. Suitable inputs for overload and single phase preventor for alternator and for each of the engine auxiliaries shall also be considered as inputs for this function.

PLC system shall continuously monitor total load on the DG set through kW transducers on the incomer breakers of the main Emergency Panel. In case the load on any of the DG sets is less than 60% of the rated value, the PLC shall assess the load on the adjacent DG set. In case the summation of the loads is within 90% of the rating of one of the DG sets, one DG set shall shut down and load shall be transferred to the second DG set. In case the total load on the system is not more than 90% of the full load rating of a single DG set, the PLC controller shall shut down two DG sets and transfer the total load to any one of the four DG sets. In case a DG set is shut down due to non-availability of adequate load and should the load increase, the PLC shall automatically start the DG set as per pre-programmed logic.

The Automatic Load Management system shall be designed to provide optimum utilization of the DG sets so that operation of the DG sets is need based with higher load factor on each set. The PLC shall ensure that that the DG sets are stopped according to the predetermined logic and interlocking scheme to provide a failsafe system.

When the voltage in the mains get restored, its quality shall be monitored for about one minute and if proven satisfactory, the PLC shall open the outgoing breakers & give stop command to DG sets.

The Logic Panel shall automatically arrange for running of DG sets to be based on number of operating hours of each DG set so that to ensure that all DG sets are operated as equally as possible.

In case of overload on the DG system, the logic panel shall be given an audio visual alarm to enable the operators to switch off loads as required and if this is not taken care of in predetermined time, the Logic Panel shall put the DG in shut down mode with alarm.

The DG set shall stop after idle running of one minute after restoration of main supply.

The DG sets reverts to standby conditions and is ready to start should the mains supply fail again.

Tenderers may note that the PLC controls and sequence of operation are indicative of requirements and the PLC shall, notwithstanding the above, be complete in all respects to achieve the control, monitoring and operation of DG sets indicated above.

Manual Mode System operation:

Under Manual mode, only single DG set shall be allowed to start or take load. No manual parallel operation of DG sets is allowed.

Under manual mode it shall be possible for the operator to start up the generator set by pressing the (START) push button.

Three attempt starting facility shall also be operative for the start up function.

Alternator circuit breakers & outgoing circuit breaker 'CLOSE' and 'TRIP' operations shall be manual by pressing the appropriate push button on the panel. Closure shall be feasible only after alternator has built up full voltage. If the load is already on 'MAINS' pressure on 'CLOSE' button shall be ineffective.

When running under manual mode, if the mains supply has failed, the load shall automatically get transferred to the alternator immediately overriding the stipulation of pressure on 'CLOSE' button.

Engine shut down, other than due to faults shall be manual by pressing a 'STOP' button.

Test Mode System operation:

When under 'TEST' mode, pressure of 'TEST' button shall complete the start-up sequence simulation and start the engine. The simulation will be that of mains failure.

Engine shall build up voltage but the set shall not close alternator circuit breaker when the load is on the mains. Monitoring performance for voltage/frequency etc. shall be feasible without supply to load.

If during TEST run the power supply has failed, the load shall automatically get transferred to alternator.

Bringing the mode selector to auto position shall shut down the sets.

2.39 Protection:

Following protection are to be incorporated in the PLC Panel along with Alarm Annunciator and Status Indication:

- Over voltage and under voltage relay.
- Reverse power relay.
- Under frequency relay.
- Over speed relay (over frequency).
- IDMT O/C & E/F.

2.40 Tests:

The following tests shall be carried out at manufacturer works:

- Insulation Resistance
- High voltage power frequency test
- Complete functional testing of PLC with simulation of all logics in auto & manual mode of operation at manufacturer's works.
- The DG synchronization Panel shall be tested at site, after DG set commissioning, for parallel operation & functional testing of PLC for all logics indicated in the specifications.
- 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 department. The inspection and tests result shall be submitted in quadruplicate for engineer-in-charge approval.
- Test certificate for all type test conducted on similar type complete switchgear assembly, relay and energy meter shall be submitted.

2.41 Drawings:

The following 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.
- PLC ladder diagram.
- PLC connection schematic diagram.

The following shall be submitted on delivery of panels:
- 4 Nos. of installation and operation manual
- 4 Nos. of all approved drawings.
- 6 Nos. of operating handle.
- Reproducible drawing on Compact Disc.

3.0 DISTRIBUTION BOARD

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:

1. Inspection:

   The inspection shall consist of following, but shall not be limited to the same –
   a. Appearance and construction.
   b. Dimensions, mounting details etc.
   c. Feeder arrangement and feeder details.
   d. Door alignment, gaskets etc.

2. Tests:

The following tests shall be carried out –

i) <u>Insulation resistance</u>:

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 two megaohm in any case.

ii) <u>High voltage power frequency test:</u>

This test shall be carried out by applying a voltage of 2.5KV for a minute.
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 LT CABLE & LT DISTRIBUTION

4.1 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, galvanized round wire/flat strip armoured Aluminium/copper conductor cables.

4.2 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.

4.3 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

4.4 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.

4.5 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.

4.6 Tests:

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.

2. Site Tests:

   The cables after installation at site shall be subjected to IR test as per instruction of EIC.

5.0 CABLE TRAY

The scope covers design and manufacture, inspection, testing and delivery of cable trays, necessary hardware, fittings & accessories.

A. General Requirements

a. The cable trays shall be prefabricated hot dip galvanized ladder type. The ladder type trays shall consist of side runners and horizontal rungs.

b. The ladder type trays and its accessories shall have rigid welded construction and shall be fabricated out of 2mm thick Hot rolled sheet steel. The rungs shall be welded to the side runners.

c. Side runners shall be 75 x 15mm channel with the flange facing inside. Rungs shall be 35 x 15mm slotted channel type construction and shall be spaced 250mm apart. All perforated channel type tray shall be 30mm high one piece channel made out of 2 mm thick sheet steel and hot dip galvanized.

d. Cable trays shall be suitable for a cable weight of 100kg/mtr. running length of tray and it shall be supported @ 2m intervals.

e. The side runner channel and all accessories will have two holes on each end for fixing splice plates. Two splice plated (one on inside face and one on outside face) will be provided for each side runner. The side runner will also have suitable holes at every meter for clearing earthling strip. Suitable tapped holes shall be provided on the runner top and bottom for supporting and fixing tray covers at every meter.

f. Hot dip galvanizing shall be done after fabrication as per relevant Indian Standards Specification. The amount of galvanizing shall be as IS 4759: 1996 (Table 1)

IS 4759 : 1996

Table 1 Mass of Zinc Coating
(*Clause* 6.1)

Sl No.	Product	Minimum Value or Average Mass of Coating (g/m^2)
(1)	(2)	(3)
i)	Castings-grey iron, malleable iron	610
ii)	Fabricated steel articles:	
	a) 5 mm thick and over	610
	b) Under 5 mm, but not less 2 mm	460
	c) Under 2 mm, but not less than 1.2 mm	340
iii)	Threaded work other than tubes and tube fittings:	
	a) 10 mm dia and over	300
	b) Under 10 mm dia	270

g. The type of construction shall be such as to facilitate easy handling, assembly and installation at site. The straight length of cable tray shall be min. 2.5 meters (without splice plate).

h. The workmanship shall be such as to ensure easy laying of cables without causing damage to cables. All surfaces shall be free from defects such as burrs, sharp edges etc.

i. The hardware shall conform to relevant Indian Standard specifications and shall be able to withstand the maximum loading conditions as required. All hardware fittings shall be hard chrome cadmium plated/zinc passivity. All hardware's shall include bolts, nuts and washers etc.

j. The bends, tees, reducers and droppers shall have bending radius of 750mm for L.T. & 1250mm for HT cables respectively.

6.0 RACEWAY/TRUNKING & JUNCTION BOX

The junction box shall be made out of 2 mm mild steel sheet.

The total depth of junction box shall be 65 mm while the width and length shall be 300 mm.

The lower compartment shall accommodate the cables running through the junction box.

The upper compartment shall be used for diverting cable out of floor trunking for further drawing through the conduit.

The upper compartment shall be provided with knock out for conduit entry on two opposite sides perpendicular to main run of the floor trunking.
The partition plate between upper and lower compartment shall have opening in staggered way for bringing out cable from trunking.

The top cover of the junction box shall be hinged type and shall be made from brass / SS. So as to give decorative look to the exposed cover top.

7.0 INTERNAL WIRING

7.1 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.

7.2 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.

7.3 Introduction

The wiring shall be done from a distribution system through main and/or branch distribution boards.

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.

For non-residential and residential buildings as far as possible DBs shall be separate for light and power or as specified in BOQ.

Only MCCB/MCB type main and branch distribution boards shall be used. HRC/ Rewireable type fuses shall not be used.

"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.

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.

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.

Each MDB/DB/Switch Board will have reasonable spare outgoing ways for future expansion.

Balancing of loads on 3-phase circuits shall be done.

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.

Conduit carrying Submain will not carry circuit / point wiring. Similarly, conduit carrying point wiring / circuit wiring will not carry Submain.

Wires of point wiring of different phases shall not be routed in same conduits/ casing capping.

7.4 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:

- Ceiling rose or connector
- Back plate (in case of stiff pendants and fluorescent fittings with down rods etc.)
- Socket outlets
- Ceiling Fan / Fan regulator
- Lamp Holder
- 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. Cable

    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.**

7.5 Types of point wiring:

7.5.1 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.

7.5.2 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.

7.5.3 Ratings of Outlets:

1. LED fittings shall be rated as per actuals.
2. Conventional Ceiling fans shall be rated at 70W and BLDC fans shall be rated as per the actuals.
3. 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.
4. 6A and 16A socket outlet points shall be rated at 100W and 1000W respectively, unless the actual values of loads are specified.
5. 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.

7.6 General Requirements:

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.

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

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

The size of conductor shall be used as follows:

Circuit	Phase & Neutral Wire Size	Earth wire Size
Lighting Circuit	1.5 sq. mm	2.5 sq. mm.
16 A Power Point Circuit	2.5 sq. mm.	2.5 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

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.

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.

7.7 SURFACE PVC CASING-N-CAPPING:

1. 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.

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

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

4. 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.

5. 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

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

7. 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.

8. 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.

9. 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.

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

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

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

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

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

7.8 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:
Dimensions shown above are outer dimensions of mini trunking.
Size of mini trunking to be used as per S.O.Q.

7.9 HMS PVC Conducting:

7.9.1 General Requirements

1. 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.

2. The conduits shall be circular in cross-section. The conduits shall be designated by their nominal outside diameter.
3. No non-metallic conduit less than 20 mm in diameter shall be used.
4. Rigid conduit accessories shall be normally of grip type.
5. Flexible conduit accessories shall be of threaded type.
6. 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.
7. Conduit pipes including all bends, unions, tees, junction boxes etc. forming part of the conduit system shall be adequately supported.
8. 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.

7.9.2 Installation

7.9.2.1 Common Aspects for Both Recessed and Surface Conduit Works

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

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.

7.9.2.2 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.

7.9.2.3 Surface Conducting Work

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.

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.

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

7.9.2.4 Fixing of Conduits in RCC Work

The conduit pipes shall be laid in position and fixed to the steel reinforcement bars by steel binding wires before the concreting is done.

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.

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.

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.

7.9.2.5 Recessed Conducting Work:

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.

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.

The chase shall be closed neatly and shall be finished flush with the wall after erection of conduit system.

All this work shall be completed before plastering of the wall & in Co-ordination with civil agency.

7.9.2.6 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.

7.9.2.7 Inspection Boxes

Suitable inspection boxes to the minimum requirement shall be provided to permit inspection and to facilitate replacement of wires, if necessary.

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.

Suitable ventilating holes shall be provided in the inspection box covers.
Fixing Switch Boxes and Accessories

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.

7.9.2.8 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.

7.9.2.9 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.

7.9.2.10 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.

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

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

7.10 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.

7.11 Switch boxes:

7.11.1 Surface switch box:

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.

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.

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.

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

7.11.2 Concealed switch box:

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.

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

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.
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.

7.11.3 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

7.11.4 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

S.No.	Descriptions	Dept.'s requirement
11.	IP degree of protection	IP20
12.	Tests	Marking, Resistance to ageing, Insulation resistance, electric strength, Temperature-rise, Making and breaking capacity, Mechanical strength

7.11.5 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

7.11.6 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

7.11.7 Lamp Holders

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

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

7.11.8 Ceiling Rose

- Ceiling Rose shall be 3 Plate ceiling rose.
- Shall be made of polycarbonate body
- Shall have brass terminals
- Shall be ISI marked

7.11.9 Door Bell

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

7.11.10 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 strands	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 portion 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 be 250°C at which Oxygen Index is 21%

S.No.	Descriptions	Dept.'s requirement
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:
    - Annealing test (for copper)
    - Conductor resistance test
    - Test for thickness of insulation
    - Tensile strength and elongation at break of insulation
    - Insulation resistance test
    - High voltage test or spark test
    - Flammability test
    - Oxygen index test
    - Test for temperature index
    - Test for halogen acid gas evaluation
    - Test for smoke density rating

C. Ceiling fans:

- 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.

D. Concealed Fan Hook:

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

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.

E. 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.

8.0 INDOOR LIGHT FIXTURE

8.1 General Requirement

8.1.1 Luminaires:

The luminaire shall be designed and tested for general lighting application as per relevant standards.

8.1.2 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.

8.1.3 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.

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.

8.1.4 Optics:

The luminaire optics shall be designed such that the lumen output shall be uniform and glare free.

8.1.5 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.

8.1.6 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

Sr. No.	Parameter	Range
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

8.2 Photobiological safety requirements:

For photo biological safety requirements, the luminaries shall comply with IS 16108.

8.3 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-

- Marking
- Total input power
- Luminaire efficacy (lm/W)
- Colour rendering index (CRI) – only initial values to be measured
- Correlated colour temperature (K) – only initial values to be measured
- Chromaticity tolerance – only initial values to be measured
- Power factor
- Luminous flux
- Luminous intensity distribution

8.4 Marking:

The Luminaire shall be marked with product information as per IS 16107 / IS 10322.

8.5 Warranty:

Luminaire shall have **05 years,** onsite replacement warranty from the supply date including Driver / Control Gear, LED, all accessories etc.

8.6 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.

9.0 OUTDOOR LIGHT FIXTURE

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 following minimum features:

- Extruded aluminum heat sink, designed to act as efficient heat dissipater important for LED luminaires.

- Pressure die cast aluminum cover on both sides for holding of extruded aluminum heat sink.
- Luminaire provided with heat resistant UV stabilized polycarbonate/ toughened glass diffuser.
- Control gear compartment is an integral part of luminaire. There shall be separate compartment for control gear and LED modules.
- LEDs are provided with secondary lens optics to get optimum optical performance.
- The driver used is specially designed to have sure voltage, open/short circuit protections.
- Luminaire is provided with a mounting bracket fixed on pressure die-cast aluminum covers for aiming adjustment.
- The luminaire housing shall have minimum IP 66, IK 07 and shall be preferably made up of die cast aluminum.

9.1.3 Lumen maintenance and failure fraction:

The luminaire shall be designed for L70 of 50000hrs (min) or as specified and failure fraction of 10% (max).

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 of silicon potted & designed for operating voltage range specified below and shall have built in voltage surge protection, short Circuit, & Over Voltage protections.

9.2 Technical requirements of luminaires:

9.2.1 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

9.2.2 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

9.2.3 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

9.2.4 Photobiological safety requirements:

For photo biological safety requirements, the luminaries shall comply with IS 16108.

9.3 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-

- Marking
- Total input power
- Luminaire efficacy (lm/W)
- Colour rendering index (CRI) – only initial values to be measured
- Correlated color temperature (K) – only initial values to be measured
- Chromaticity tolerance – only initial values to be measured
- Power factor
- Luminous flux
- Luminous intensity distribution

9.3.1 Marking:

The Luminaire shall be marked with product information as per IS 16107 / IS 10322.

9.3.2 WARRANTY:

Luminaire shall have 05 years, onsite replacement warranty from the supply date including Driver / Control Gear, LED, all accessories etc.

9.3.3 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.

10.0 EARTHING

10.1 Scope:

The scope of work under this section covers the earthing of various panels, distribution boards and utilization equipment.

10.2 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.

10.3 electrode earth PIT:

Earth electrode and installation: High-grade solid steel rods molecularly bonded with 99.9% pure electrolytic copper with minimum coating thickness of 250 microns should be used as earth electrode. The rods must be UL listed as well as tested according to IEC62561-2 and comply to the requirements of IEC 60364-5-54. The rods also should withstand short circuit currents as per the chart above. All fasteners used should confirm to the requirements of the above standards. Earth enhancing compound (Soil conductivity improver) used should be tested according to IEC62561 – 7 from an NABL accredited laboratory. Exothermic welding material used shall be tested as per IEEE 837

10.4 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.

10.5 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.

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

Sr. No.	Size of incomer cable	Size of copper or GI strip/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	

10.6 Grounding equipment's:

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.

10.7 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.

10.8 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.

10.9 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.

10.10 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

10.11 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.

11.0 DWC PIPE & MANHOLE

DWC POLYETHYLENE PIPE

(**Class SN 8 Structured Double Wall (Non-Smooth External Annular Corrugated wall & Smooth Internal wall) Polyethylene Piping System for non-pressure underground Sewerage & Drainage Applications)**

Scope

This specification covers the requirements for manufacturing, supplying, transportation, handling, stacking of Class SN 8 Structured Double Wall (Non-Smooth External Annular Corrugated wall & Smooth Internal wall) Polyethylene Piping System for non-pressure underground Sewerage & Drainage Applications herein after called the *DWC PE Piping System.*

Applicable Codes

The manufacturing, testing at factory, supplying, transportation, handling, stacking, installation, jointing, and testing at sites shall comply with all currently applicable statutes, manuals, regulation, standards & codes. In particular, in addition to all relevant National Standards, following International standards with latest revisions shall be referred. If requirements of these specifications are at variance with any other standards, this particular document shall govern the proceedings.

EN 13476-1	Plastics piping Systems for non-pressure underground drainage and sewerage- Structured-wall piping systems of Polyethylene (PE) Part 1 : General requirements and performance characteristics
EN 13476-3	Plastics piping Systems for non-pressure underground drainage and sewerage- Structured-wall piping systems of Polyethylene (PE) Part 3 : Specifications for pipes and fittings with smooth internal and profiled external surface and the system, Type B

Other International Codes / Standards (EN/ ISO) which are integral part of above two standards as normative references form a significant portion of this specification document.

Manufacturing

The DWC PE Piping System of stiffness class designation SN 8 shall confirm to the European Union standards as mentioned above and shall be configured as per the indicative Cross-sectional & Profile Drawings (Annexure A &B) annexed herewith. Each pipe shall be coupler (on-line or off-line) and spigot type along with rubber sealing ring (as designated under above international specifications).

Transportation

The arrangement of loading the pipes in a telescopic manner is advised, i.e. smaller diameters inserted into the next higher sizes of pipes. While loading the pipes onto the truck, care should be taken that the coupler- end should be arranged alternatively in the corresponding layers so as to avoid the damage to the coupling/ socket ends.

Handling

Following Recommendations shall be followed while handling the pipes:

- Adherence to National Safety requirements

- Pipes to be smoothly lowered to the ground
- Pipes should not be dragged against the ground to avoid the damages to the Coupler/pipes.
- 800mm and larger diameter pipes are carried with Slings at two points spaced approximately at 3 Meters apart
- For smaller diameters (400mm – 800mm) one lift point shall be sufficient & can be handled either manually or mechanically
- Do not use a loading Boom or Fork Lift directly on or inside pipe.

Pipe Storage at Site

- Stockpiling shall be done temporarily on a Flat Clear Area as per Fig. 1 & 2.
- For avoiding collapse of Stacks, use Wooden Posts or Blocks
- Stacking shall not be higher than 2.5 Meters
- While stacking, alternate the socket/coupler ends at each row of stacked pipes as per Fig. 2.

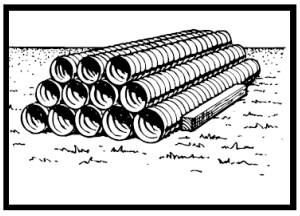

Fig 1

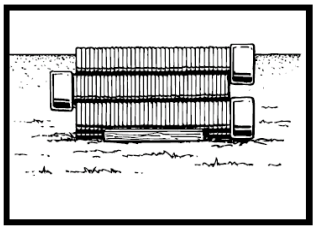

Fig 2

Lowering, Laying & jointing of Pipes

The width of a Sewer Trench depends on the soil condition, type of side protection needed and the working space required at the bottom of Trench for smooth installations. Increase in width over required minimum would unduly increase the load on pipe and cost of road restoration. Considering all above factors, the Minimum Trench Width is specified as per Table below :-

Indicative Trench Widths**	
Pipe Diameter (mm)	Trench Width (M)
75-170	0.6
250	0.7
400	0.9
600	1.2
800	1.3
1000	1.8

**In actual practice the trench width can be as narrow as possible but adequate to allow the workmen to execute the job satisfactorily.

The pipe segment between two manholes shall be laid approximately in straight line without any vertical undulations. However, on the strength of its flexibility, the DWC PE Piping system can be laid in very smooth curve if found necessary. The piping system shall rest on the carefully prepared bedding portion of the Backfill Envelope and at appropriate jointing locations the trenches shall be excavated deeper to accommodate the bulges of coupler-spigot joints. However, special care shall be ensured as mentioned below:-

- Excavation of trenches shall be carried out in accordance with the drawing & specifications and as directed by the field engineer as well.

- The piping system shall be laid and jointed in true to gradient with the help of sight rails and boning rods as detailed in CPHEEO Manual on Sewerage and sewerage treatment. The levels need be checked with calibrated modern Levelling Instrument. Specific care shall be taken to prevent entry of sand / mud /slush/ any other foreign material etc into the system during the installation operation.

The structural property of the system suggests that a minimum cover of 300 mm adequate even for maximum quantum of superimposed (live) load.

In case of wider trenches than required (above table), the permission of the competent authority shall be necessary.

The bedding area is an essential portion of Back fill Envelope and shall be constructed with proper bedding material as computed in accordance with appropriate international code of practice for structural bedding design mentioned in the list of normative references under EN 13476.The bedding shall be laid to specified thickness and gradient with proper manual compaction of the aggregate.

The moulded on-line coupler (or separate coupler integrated to the pipe in case of lower sizes) will have a suitable internal surface for push-fitting the said end over the spigot end of the next pipe. On first valley of the corrugation of said spigot end (destined to receive the pushed coupler) the sealing rubber ring of standard (EN 13476) quality shall be placed so that the coupler end of the pipe smoothly but tightly slides over the sealing ring for making an absolute watertight joint. Similar system is also used for fabricated accessories or moulded fittings required such as Tee, Bends, Elbows, Reducer end caps for the purpose of installation of the system related to drainage/sewerage.

For quality connections following steps are to be ensured, failing which the performance aspects are to be severely compromised:-

The non-coupler (socket) end needs to be thoroughly cleared and shall be free from any foreign material

- Clean and lubricate the coupler end of the pipe, if required.
- Lubricate the exposed Gasket in the same manner, if required.
- Keep the non-coupler end free from dirt, backfill material, and foreign matter so that the joint integrity is not compromised.
- Push the coupler into non-coupler and align properly. Always push coupler end into non-coupler end.

For smaller diameter pipes simple manual insertion shall be sufficient. It should be ensured that the coupler end is adequately 'homed' within non-coupler end to ensure installation and tight joining seal. Therefore prior to insertion always place a 'Homing Mark' on appropriate corrugation of the 'Non-Coupler End'.

Construction of backfill envelope and final backfilling of the trenches

DWC PE Piping System with well compacted Backfill Envelope along with the bottom and sides of trench (native soil) work together to support soil overburden and superimposed (traffic) loads. The carefully constructed Backfill Envelop has three distinct but non-isolated stages. The construction need to be done stage by stage as per the sequence stated below:

- Bedding portion
- Up to Haunch level

- Remaining portion

The material for backfill envelop shall be in accordance with the structural design of flexible buried conduit as per relevant international codes. It can be the same material that were removed in the course of excavation or it can be fine sand/course sand/gravel / moram /other form of course / fine aggregates depending on the effected Design Load [Overburden + Superimposed (Live) load]. However, in no circumstances, the flexible pipe should not be embedded in cement concrete (un-reinforced or reinforced) which invariably induces undesired rigidity in the system.

- The remaining portion of backfilling which do not contribute to the structural integrity of the system may be the materials that were removed in the course of excavation or any other foreign material as may be required to suit the particular site condition. These materials shall consist of at least clean earth and shall be free from large clod or stone above 75 mm, ashes, refuse and other injurious materials.

- After completion of bedding portion of the Backfill envelop and subsequent lying of pipes, etc, first the haunch portion & then upper portion of Backfill Envelope shall be constructed as per design around the pipe. Voids must be eliminated by knifing under and around pipe or by some other indigenous tools.

- The compaction, by hand rammers or compactors with necessary watering to a possible maximum level of proctor density shall be ensured.

- Backfilling shall start only after ensuring the water tightness test of joints for the concerned sewer segments. However, partial filling may be done keeping the joints open.

- Precautions shall be taken against floatation (if at all necessary) as per the specified methodology and the minimum required cover.

- Continuity of the pipe segments in between two manholes is required to be ensured in the same modality as practiced for pipeline. Hydraulic testing of pipes shall be done, if specifically asked for by the client for any specific stretch.

Jointing

- Elastomeric sealing ring joints/Solvent cement joint

- These pipes shall be socketed on automatic socketing machine with self-socket length. Such pipes shall be either joined with solvent cement or groove inside with rubber ring.

Continuity Test /Hydraulic Testing

- All lengths of the sewer and drain shall be fully tested for water tightness by means of water pressure maintained for not less than 30 minutes. Testing shall be carried out from manhole to manhole. All pipes shall be subjected to a test pressure of at least 1.5 mtrs. head of water. The test pressure shall, however, not exceed 6 metres head at any point. The pipes shall be plugged preferably with standard design plugs with rubber plugs on both sides. The upper end shall, however, be connected to a pipe for filling with water and getting the required head poured at one time permit.

- Sewer lines shall be tested for a straightness by :

- Inserting a smooth ball 12 mm less than the internal diameter of the pipe. In the absence of obstruction such as yarn or mortar projecting at the joints the ball should roll down the invert of the pipe and emerge at the lower end.

- Means of a mirror at one end and a lamp at the other end. If the pipe line is straight the full circle of light will be seen otherwise obstructions or deviations will be apparent.

- The contractor shall give a smoke test to the drain and sewer at his own expense and charges, if directed by the Engineer in charge.

- A test register shall be maintained which shall be signed and dated by Engineer in charge.

Measurements

The mode of measurement shall be as per BOQ/Schedule B.

SFRC Manhole cover Frame

Manhole Covers
The covers and frames shall conform to IS 1726 for cast Iron and IS 12592 for pre-cast concrete covers and shall be of the following grades and types.

Grades	*Grade Designation*	*Type/shape of cover*
Light Duty	LD - 2.5	Rectangular, Square, Circular
Medium Duty	MD - 10	Rectangular, Circular and Square (for pre-cast concrete manhole covers)
Heavy Duty	HD - 20	Circular-Square, Rectangular, (Scrapper Manhole)
Extra Heavy Duty	EHD - 35	Circular, Square, Rectangular, (Scrapper Manhole)

Pre-Cast Concrete Manhole Covers & Frames
Pre-cast reinforced cement concrete manhole covers intended for use in sewerage and water works shall generally conform to IS 12592

Materials
Cement: Cement used for the manufacture of pre-cast concrete manhole covers shall be 43 grade Portland cement conforming to IS-8112.

Aggregates: The aggregates used shall be clean and free from deleterious matter and shall conform to the requirements of IS -383. The aggregates shall be well graded and the nominal maximum size of coarse aggregate shall not exceed 20 mm.

Concrete: The mix proportions of concrete shall be determined by the manufacturer and shall be such as will produce a dense concrete without voids, honey combing etc. The minimum cement content in the concrete shall be 410 kg/m3 with a maximum water cement ratio of 0.45. Concrete weaker than grade M-30 (design mix) shall not be used. Compaction of concrete shall be done by machine vibration.

Reinforcement

A) The reinforcement steel shall conform to IS 1786. Reinforcement shall be clean and free from loose mill scale, loose rust, and mud, oil, grease, or any other coating

which may reduce or destroy the bond between concrete and steel. A light film of rust may not be regarded as harmful but steel shall not be visibly pitted by rust.

B) Fibers Steel: The diameter/equivalent diameter of steel fibers where used, shall not be greater than 0.75 mm. The aspect ratio shall be in the range of 50 to 80. The minimum volume of fibers shall be 0.5 percent of the volume of concrete

The reinforced concrete manhole cover and frame shall be designed in accordance with the provisions of IS 456. Clear cover to reinforcement shall not be less than 15 mm.

Shapes and Dimensions

Shape, dimensions and tolerance of pre-cast concrete manhole covers and frames shall conform to IS 12592. Outside dimension of cover at top shall match with corresponding frame so that the maximum clearance at top between the frame and the cover all round the periphery is not more than 5 mm and the top surface of the frame and covers, is in level within a tolerance of +5 mm.

For facility of removing the cover from the frame, suitable taper matching with taper given for the frame shall be provided to the periphery of the cover.

Lifting Device

The minimum diameter of mild steel rod used as lifting device shall be 12 mm for light and medium duty covers and 16 mm for heavy and extra heavy duty covers. The lifting device shall be protected from corrosion by hot galvanising or epoxy coating or any other suitable treatment.

Finishing & Coating

To prevent any possible damage from corrosion of steel the underside of the covers shall be treated with anticorrosive paint. The top surface of the covers shall be given a chequered finish.

In order to protect the edges of the covers from possible damage at the time of lifting and handling it is necessary that the manhole covers shall be cast with a protective mild steel sheet of minimum 2.5 mm thickness around the periphery of the covers. Exposed surface of mild steel sheet shall be given suitable treatment with anticorrosive paint or coating. To prevent the top outer edge of frame from possible damages, it shall be protected by 25 mm X 3 mm mild steel flat as part of the frame.

Physical Requirements

General: All units shall be sound and free from cracks and other defects which interface with the proper placing of the unit or impair the strength or performance of the units. Minor chipping at the edge/surface resulting from the customary methods of handling during delivery shall not be deemed for rejecting.

Load Test: The breaking load of individual units when tested in accordance with the method described in IS 12592 shall be not less than the values specified in Table 19.4.

Grade of Cover	Type	Load in Tonnes	Diameter of Blocks in mm
EHD - 35	Circular, Square or Rectangular	35	300
HD - 20	Circular, Square or Rectangular	20	300
MD - 10	Circular or Rectangular	10	300
LD - 2.5	Rectangular, Square or Circular	2.5	300

Fixing
The frames of manhole shall be firmly embedded to correct alignment and level in RCC slab or plain concrete as the case may be on the top of masonry which shall be paid as extra unless specified otherwise.

Measurements:
The manhole covers shall be enumerated under relevant items.

Rates:
The rate shall include the cost of materials and labour involved in all the operation described above except fixing of frames and covers which shall be paid as extra unless specified otherwise in the item.

Footrests
Footrests shall be of 20 mm M.S. square or round bars as specified.

PVC rungs
Specifications shall be as per manufacturer.

12.0 UPS SYSTEM WITH BATTERY BACKUP

12.1 Scope of Work:

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

12.2 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

12.3 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.

12.4 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.

12.5 **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.

12.6 Technical Parameters:

Sr. No.	Parameters	Specifications
A.	UPS Capacity	AS per BOQ

Sr. No.	Parameters	Specifications
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.
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

Sr. No.	Parameters	Specifications
		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

12.7 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.

12.8 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.

12.9 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:

- Interconnection Cable Check.
- Light load test.
- UPS Auxiliary device test.
- AC input failure test.
- AC input return test.
- Transfer & re-transfer test.
- Line regulation test.
- Load regulation test.
- Harmonic component test.
- UPS efficiency test.
- Overload capacity test.
- 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.

12.10 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:

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

13.0 JUNCTION BOX

A. IP 66 / IP 67 / IP 69 for outdoor Junction boxes (with/without Terminals) made of PC - GFS (From 1.5 sqmm upto 50 sqmm Cable conductors).

B. Junction Boxes in RAL 9011 colour Black ,cable entries via knockouts

C. The junction box shall fulfill the following standards: Weatherproof , UV resistant due to solar radiation, Rainwater proof, temperature resistant. Salt water proof & shall be suitable for off-shore applications, external brackets for wall fixing included

,rated insulation voltage 690 vac/dc ,Halogen free, Silica free, ,IK 09 degree of protection against mechanical load.

D. The lower compartment shall accommodate the cables running through the junction box.

E. EC 60670-22 : Particular requirements for connecting boxes and enclosures

F. IEC 60695 – 2 – 11 : Flame – retardant & Self-extinguishing.

G. Glow Wire tested at minimum 960 deg C.

H. IEC 60529 : IP 66 / IP 67 / IP 69 degree of protection

14.0 LIGHTNING PROTECTION SYSTEM

14.1 General

The supply and installation of lightning protection shall be carried out by the contractor to the latest edition of IS : 62305

Installation of lightning protection scheme shall include supply and installation of (a) G.I. spacer and clamp for fixing 25 mm x 3 mm G.I. conductor on roof / columns / walls by lead rawal plugs / PVC sleeves (b) hardware such as P.G. clamps (c) Cadmium plated bolts, nuts, washers, screws, etc. lighting masts along with all hardware and (d) test link and installation of 25 mm x 3 mm G.I. down conductor. Materials required for completion of the work, shall be arranged to be supplied and installed by the contractor.

The work pertains to providing the lighting protection system for project mentioned elsewhere in the tender. The height of the block form the ground level would be about 30 metres. The scope of work in the present work is the installation of horizontal roof conductors on the building parapet wall on the terrace, providing the down conductors, providing the earth termination and the lightning air termination. The fixing of the lighting conductor must as well as connections of the roof conductors to the same shall be carried out by the contractor in the specified manner.

The work covered in this Tender shall strictly conform to IS : 2309 with latest amendments – Indian Standard Code of Practice for the protections of building and allied structures against lightning, drawing and as per instructions of Engineer-in-charge.

14.2 Roof Conductors:

The roof conductors shall consist of G.I. plate as of 25 mm x 3 mm size. The roof conductors shall be installed along the top periphery of the parapet wall supported on GI spacers of approved design. These spacers shall be placed at regular intervals of about 600 mm. The GI strip for the roof conductors shall be adopted in as large length as possible so as to minimize the number of joints in the system. Plates in full length of approximately size meters each shall be preferably used and would be preferred to bend the flats to suit the building profile instead of cutting and jointing.

Joints in the horizontal run of the roof conductors, if necessary shall be provided by soldering / welding. The contractor may adopt any other suitable method of joining subject to the approval by the Department.

The roof conductors shall be connected to the air termination in a manner to be approved by the Department.

The roof conductors shall be installed so as to form a closed ring.

The roof conductors shall be painted with two coats of green paint before installation.

14.3 Down Conductors:

The down conductors shall run on each side of the building starting from a point in the roof conductor described above and coming down vertically along the structure/ building column of the building as per drawing and remaining at a point about 1 meter above outside ground level. The size and method of installations, etc. of the down conductors shall be the same as for the roof conductors mentioned above.

The location of the down conductor has been dept such that it may not be necessary to erect a scaffolding for the same and it should be possible for the contractor to install the down conductors from the landings of various floors. If any temporary plank / wooden platform etc. are required at various floor landings for fixing the down conductors, the same would also be provided by the contractor himself. Contractor has to make necessary arrangement as per site conditions for the installation of down / roof conductors. The roof conductors shall be painted with two coats of green paint before installation.

14.4 Earth Terminations:

The earth termination system consists of a continuation of the down conductor from a point about one metre above the ground level upto the earth electrode for the final connection of the lightning protection system to the earth. A suitable openable link will be provided between the down conductor and the earth conductor for facility of installation and testing. The earth conductor from this link downwards shall be G.I. flat of 37 mm x 6 mm section only painted with anticorrosive bituminous paint.

The earth pit, earth electrode and the earth conductor below the ground level shall be provided and connected as per specifications.

14.5 Quality of work and safety:

The works shall be carried out with best workmanship and special care will be taken to see that the roof conductors as well as down conductors are in approved line and level. All drilling of holes in the walls, etc. shall be carried out only by using electric drills with suitable drill and under no circumstances punching. Hammering of holes will be allowed. The contractor shall ensure complete safety of his personnel during the execution of the work and would exercise all possible care for avoiding any accidents, etc. The department will not be responsible for any accident that may occur to the contractor's workers at site during the execution of the job.

15.0 ADDRESSABLE FIRE ALARM SYSTEM:

15.1 General Scope of Works

15.1.1 This section of the specification includes the design, supply, installation, and connection of a microprocessor controlled; addressable fire alarm equipment required to form a complete coordinated system ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control panels, auxiliary control devices, annunciator, power supplies, and wiring as per shop drawings and specified herein.

15.1.2 The system shall be designed such that each loop shall limited to only 80% of its total capacity at initial installation.

15.1.3 All equipment/components shall be new & the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

15.1.4 All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc. before beginning system installation. Refer to the riser/connection diagram for all specific system installation/termination/wiring data.

15.1.5 All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

A Submittals and Shop drawings:

- Sufficient information shall be clearly presented and shall include manufacturer's name, model numbers, power requirements, equipment layout, device arrangement and complete wiring.
- Sequence and description of operation.
- Product Data for each type of equipment, initiating device, signal device, peripheral device and cable provided on the project.
- Shop drawings shall include battery calculations, floor plans and wiring diagrams.

B Basic System

- The system shall be a complete, ELV supervised fire detection and evacuation system using fire fighter telephone with microprocessor-based operating system having the following; capabilities, features and capacities:
- Communication between network nodes, each supporting an interactive, self-standing, intelligent local control panel, with system wide displays. Any network node shall be capable of supporting a local system in excess of 4000 input/output points.
- The local system shall provide status indicators and control switches for all of the following functions:

  a. Audible and visual notification alarm circuit zone control.
  b. Status indicators for sprinkling system water-flow and valve supervisory devices. (if any)
  c. Any additional status or control functions as indicated on the drawings, including but not limited to; emergency generator functions, fire pump functions, door unlocking and security with bypass capabilities.

- Each intelligent addressable device or conventional zone on the system shall be displayed at the fire alarm control panel by a unique alphanumeric label identifying its location.

C Approvals

All the equipment shall have proper listing and/or approvals and shall comply to the requirements of the following recognized agencies.

UL – Underwriters Laboratories Inc. FM –Factory Mutual

The Fire Alarm Control Panel and all modules/devices shall meet the modular listing requirements of Underwriters Laboratories, Inc. and Factory Mutual. Each subassembly, including all printed circuits, shall include the appropriate UL/ EN modular label. This includes all printed circuit board assemblies, power supplies, and enclosure parts. Systems that do not include modular labels may require return to the factory for system upgrades, and are not acceptable.

D Quality Assurance:

a. Manufacturer:

- The manufacturer of the detection components shall have experience in the design and manufacture of similar types of detection systems and who refer to similar installations providing satisfactory service.
- The name of the manufacturer, part numbers and serial numbers shall appear on all major components.
- All detection devices, components and equipment shall be the products of the same manufacturer.
- All devices, components and equipment shall be new, standard products of the manufacturer's latest design and suitable to perform the functions intended.
- All products ranging from PANEL to Detectors & Devices should be manufactured under single source of manufacturer to usher continuous line of support round the year

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E Fire Alarm Condition:

- Sound an audible alarm and display a custom screen/message defining the building in alarm and the specific alarm point initiating the alarm in a LCD display.
- Log to the system history archives all activity pertaining to the alarm condition.
- Print to system printer (where required) alarm condition information.
- Sound the ANSI 117-1 signal with synchronized audible and synchronized strobes.
- Audible signals shall be silenced from the fire alarm control panel by an alarm silence switch. Visual signals shall be programmable to flash until system reset or

alarm silencing, as required.

- Activation of any detector in a single elevator lobby or an elevator equipment room shall indicate at fire alarm control panel, cause the recall of that bank of elevators to the ground/stilt floor and the lockout of controls.
- HVAC shut down shall, be accomplished by system operated duct detectors as per local requirements. PAC units will be shut down by control relay modules in the loop.
- Door closure devices shall operate by floor.
- Activation of stairwell pressurization fans, smoke purge and damper control shall be as required.

15.2 Performance Requirements

A General Performance: Comply with NFPA 72/EN and all contract documents and specification requirements.

B All interconnections between this system and the monitoring system shall be arranged so that the entire system can be UL/EN-Certificated.

C System shall be a complete, supervised, non-coded, addressable multiplex fire alarm system conforming to NFPA 72/ EN.

The system shall have Style 6 circuits for each floor. The system shall operate in the alarm mode upon actuation of any alarm initiating device. The system shall remain in the alarm mode until all initiating device(s) are reset and the fire alarm control panel is manually reset and restored to normal.

D The system shall be capable of the following configurations. Both configurations are permitted on the same network.

E The system shall support minimum three loops of 300 addressable devices & detector of any combination (unless specified otherwise by OEM) each of which may be divided in any ratio on one, two, three, or four separate, isolated Class B circuits.

F The system shall have an optional digital alarm communication transmitter.

G The system shall provide an off-normal warning prior to reset for all active devices.

H The system shall be capable of remote monitoring, a proprietary software system that provides a graphical representation of the fire alarm control panel at a remote PC when connected via Ethernet to the system. The display will show the exact state of the panel, including blinking LEDs, and with menu buttons for control.

I The system shall be capable of being configured via a PC Tool.

J In networked systems, each of control panels shall be configurable to be a global annunciator, capable of viewing all other control panels on the network.

K The system shall provide the following functions and operating features:

The FACP and auxiliary power panels shall provide power, annunciation, supervision and control for the system.

Provide Class A initiating device circuits.

Provide Style 7 signaling line circuits for the network.
Provide two Class A notification appliance circuits. Arrange circuits to allow individual, selective, and visual notification by zone. Notification appliance circuits shall be zoned to correspond with the building fire barriers and other building features.

Strobes shall be synchronized throughout the entire building.

Provide ELV supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control panel.

L The system shall provide a field test function where one person can test the complete system or a specific area while maintaining full operational function of other areas not being tested. Alarms, supervisory signals, trouble signals shall be logged in system history during the walk-test.

M Alarm functions shall override trouble or supervisory functions. Supervisory functions shall override trouble functions.

1. Supervisory Condition:

- Display the origin of the supervisory condition report at the fire alarm control panel graphic LCD display.
- Activate supervisory audible and dedicated visual signal.
- Audible signals shall be silenced from the control panel by the supervisory acknowledge switch.
- Record within system history the initiating device and time of occurrence of the event.
- Print to the system printer (where required) the supervisory condition.

2. Trouble Condition:

- Activate trouble audible and visual signals at the control panel and as indicated on the drawings.
- Audible signals shall be silenced from the fire alarm control panel by a trouble acknowledge switch.
- Trouble conditions that have been restored to normal shall be automatically removed from the trouble display queue and nor require operator intervention. This feature shall be software selectable and shall not preclude the logging of trouble events to the historical file.
- Record within system history, the occurrence of the event, the time of occurrence and the device initiating the event.
- Print to the system printer (where required) the trouble condition.

3. Security Condition:

- Display at the fire alarm control panel with LCD display, the origin of the security condition report. A dedicated security LED shall flash until the alarm has been acknowledged, then revert to a steady "ON" state.

- The control system shall be capable of bypassing the alarms from an individual security system installed within selected areas. The pass code allowing this function shall be assignable to individual security personnel and each bypass action shall be logged to system history. Intrusion alarms occurring during a bypass period shall be logged to history and displayed but no audible alarm shall occur at the control panel.

- Print to the system printer (where required) the security condition.

- The Fire Control Panel shall be "UL" 1076 listed or EN for security purposes.

4. Control Panel

The fire alarm control panel shall be microprocessor based using multiple microprocessors throughout the system providing rapid processing of smoke detector and other initiation device information to control system output functions.

- The system modules shall communicate with an RS 485 network communications protocol. All module wiring shall be to terminal blocks.

- The system shall be capable of the following configurations. Both configurations are permitted on the same network.

- The control panel shall be capable of expansion in SLC loops. Each loop shall support minimum 125 analog/addressable devices for a system capacity of 800points. The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit 80-character liquid crystal display, individual, color coded system status LEDs, and a QWERTY keypad for the control of the fire alarm system. Said LCD shall also support graphic bit maps capable of displaying the company name and logo of either company.

- The panel shall have a built-in power supply of and battery charger. Battery charger shall be able to charge the system batteries up to 200AH. The Panel shall have the capacity of connecting additional 200 panels or Network terminals using network card, with redundancy in the network, TCP/ IP connectivity for Central Monitoring station

The system shall be capable of supporting unshielded wiring applications.

5. System Components:

- The System Periphery board / Fire Alarm Panel shall be capable of 125 intelligent devices & detector of any combination (unless specified otherwise by OEM) distributed between one, two, three, or four Class B SLC circuits. Any trouble on one circuit shall not affect the other circuit. This module controls the signaling from the initiation devices reporting alarms and troubles to the control panel. This module shall also provide the

signaling to the field devices for the controlling the output of specific initiation devices. The on-board microprocessor provides the periphery board with the ability to function even if the main microprocessor fails. LED's on the board shall provide annunciation for the following; Power, Gnd. Fault, Alarm, Trouble. This board is integral to the system.

- The system periphery board shall be capable of supporting two system drivers of 125 intelligent devices & detector of any combination (unless specified otherwise by OEM) distributed between one, two, three, or four Class B SLC circuits, for a total panel capacity of up to 800 addressable devices with additional loop cards. Any trouble on one circuit shall not affect the other circuit. This module controls the signaling from the initiation devices reporting alarms and troubles to the control panel. This module shall also provide the signaling to the field devices for the controlling the output of specific initiation devices. The on board microprocessor provides the periphery board with the ability to function even if the main microprocessor fails. LED's on the board shall provide annunciation for the following: Power, Gnd. Fault, Alarm, Trouble. This board is integral to the system.

- The Signal Line Circuits (SLC) shall be tested for opens, shorts and communications with all addressable devices installed before connection to the control panel. Systems without this capability shall have a test panel installed for initial testing to eliminate any possible damage short term or long term to the control panel. After initial testing replace the test panel and proceed with complete testing.

- The standard Operator Interface shall have the ability to view events, acknowledge, silence, and reset the system and any networked control panels, when configured as a global PMI.

- The LED Operator Interface shall have the ability to view events, acknowledge, silence, and reset the system and any networked control panels, when configured as a global PMI. Additionally, the operator interface provides twELVe multicolored configurable LEDs for annunciating system status

- System response time from alarm to output shall be an average of three (3) seconds.

a. All system cards and modules shall have Flash memory for downloading the latest module firmware.

b. Passwords:
   - Technician Level Password - There shall be a 4-character password that a user must enter into the control panel in order to perform such maintenance- and control-related functions at the panel as:

a. Arming and disarming devices.

1. Activating and deactivating the History Log function and deleting obsolete entries.
2. Changing the system time and date.

   - Maintenance Level Password - There shall be a 4-character password that a user must enter into the control panel in order to access the panel's reporting functions and walk test functions.

- Acknowledge Silence able Reset Access - There shall be a key required to open a locked cabinet that a system user must use in order to acknowledge events, turn silence able audible and visuals on and off, and perform panel resets.

6. Power Supply

- The system Power Supply shall be a 170 Watt, 6-amp that provides 24VDC power for system operation. The power supply shall be filtered and regulated. The power supply provides power for all system operation, including signaling line circuits, notification appliance circuits, auxiliary power, battery charger, and all optional modules The power supply shall be rated for 120/240 VAC 50/60 Hz.

- The power supply provides power for all system operation, including signaling line circuits, notification appliance circuits, auxiliary power, battery charger, and all optional modules. The power supply shall be rated for 120/240 VAC 50/60 Hz.

- The battery charger shall be able to charge the system batteries up to 200 AH batteries. Battery charging shall be microprocessor controlled and programmed to select battery sizes.

- Transfer from AC to battery power shall be instantaneous when AC voltage drops to a point where it is not sufficient for normal operation.

7. System Enclosures:

- Provide the enclosure needed to hold all the cards and modules as specified. The enclosures shall be either black or red. The outer doors shall be capable of being a left hand open or a right hand open. The inner door shall have a left hand opening. System enclosure doors shall provide where required ventilation for the cards in the enclosure.

8. System Printer:

- The system printer shall be operated from a Remote Printer Module, which shall be mounts outside the enclosure. This module shall provide a parallel port and 2 serial ports for RS 232 protocol. One of the serial ports shall be able to be programmed for RS485 protocol. Supervised network connection shall be either Style 4 or 7 as directed.

- This parallel printer shall be supervised for: On/Off line, out of paper, paper jam, power off, and connection the system. The printer shall be a; high speed, 24 dot matrix, wide carriage, and capable of using tractor or friction fed paper. The printer shall contain diagnostic LED's for ease in maintenance.

9. Intelligent Initiation Devices:

- All initiation devices shall be insensitive to initiating loop polarity. Polarity insensitive wiring allows fire detection devices to operate flawlessly even when detector and devices wiring polarity are inverted on the wrong screw terminals. When wiring polarity doesn't need to be observed, wiring troubleshooting is greatly reduced, this will also save time of installation

Specifically, the devices shall be insensitive to plus/minus voltage connections on either Style 4 or Style 6 circuits.

B.

- **The multi-criteria sensor detector** shall be an intelligent digital photoelectric detector with a programmable heat detector. The detector shall have a multicolor LED to streamline system maintenance/inspection by plainly indicating detector status as follows: green for normal operation, amber for maintenance required, red for alarm. Detector shall have shock-resistant thermistor to sense temperature changes. The "on-board" Fire technology shall allow the detector to gather smoke and thermal data, and to analyze this information in the detector's "neural network Neural Network is a dynamic detection technology system. It simulates the work pattern of human brain. It can develop the knowledge as to refine the level of detection technology. It means, neural network can analyze, learn and adapt according to environmental or physical conditions of premises and trigger the output accordingly. The characteristics of fire are stored in the memory patterns in the microprocessor of detector. Hence, the microprocessor can adapt the characteristics of the environment and able to distinguish between actual fire and deceptive phenomena.

- Detectors shall be listed for use as open area protective coverage, in duct installation and duct sampling assembly installation and shall be insensitive to air velocity changes. The detector communications shall allow the detector to provide alarm input to the system and alarm output from the system within four (4) seconds. Detectors shall be programmable as application specific, selected in software for a minimum of eleven environmental fire profiles unique to the installed location. These fire profiles shall eliminate the possibility of false indications caused by dust, moisture, RFI/EMI, chemical fumes and air movement while factoring in conditions of ambient temperature rise, obscuration rate changes and hot/cold smoke phenomenon into the alarm decision to give the earliest possible real alarm condition report. The intelligent smoke detector shall be capable of providing three distinct outputs from the control panel. The system-controlled output functions shall be from an individual or unique input of smoke obscuration, a thermal condition or a combination of obscuration and thermal conditions. The detector shall be designed to eliminate calibration errors associated with field cleaning of the chamber. The detector shall support the use of a relay and LED remote indicator at the same time. Low profile, white case shall not exceed 2.5 inches of extension below the finish ceiling. Detector wiring shall not require any special shielded cable. It should have a multi detector status LED: Green for normal and red for alarm.

- **Thermal/ Rate of Rise Detectors** shall be rated at 135 degrees for fixed temperature. Detectors shall be constructed to compensate for the thermal lag inherent in conventional type detectors due to the thermal mass, and alarm at the set point of 135 degrees Fahrenheit. The choice of alarm reporting as a fixed temperature detector shall be made in system software and be changeable at any time without the necessity of hardware replacement. The detectors shall be installed according to the requirements of NFPA 72/EN for open area coverage.

10. Device Programming Unit

- Addressable smoke and thermal detectors shall provide dual alarm and power/polling bi-colour LEDs. Both LEDs shall flash green under normal

conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady red illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.

- The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity.

- Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72.

- The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base options shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications. The system shall also support an intelligent programmable sounder base, the programmable sounder base shall be capable of providing multiple tones based on programming and at a minimum be capable of providing a Temp-4 tone for CO (Carbon Monoxide) activation and a Temp-3 tone for fire activations and be capable of being synchronized with other programmable sounder bases and common area notification appliances; 85 DBA minimum.

- Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (PHOTO, THERMAL).

- Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.

- Addressable devices shall store an internal identifying code that the control panel shall use to identify the type of device.

- A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.

- Addressable modules shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep ELV box. An optional surface mount Lexan enclosure shall be available.

- Detectors / Bases with connection terminals exposed to Ceiling / False Ceiling shall be provided with Protective Insulation of the same make as of Detectors.

11. Manual Call Points OR Pull stations.

- Addressable manual call point shall send data to the panel representing the

state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.

- All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
- Manual fire alarm boxes shall be constructed of Lexan / ABS Plastic with clearly visible operating instructions provided on the cover. The word FIRE / Fire Sign shall appear on the front of the stations.`

12. Monitor Module.

    1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device).

    2. The two-wire monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep ELV box or with an optional surface back box.

    3. The IDC zone shall be wired for operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

13. Addressable Control Module.

    1. Addressable control modules shall be provided to supervise and control the operation of one conventional devices of compatible, 24 VDC powered polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay.

    2. The control module shall mount in a standard 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep ELV box, or to a surface mounted back box.

    3. The control module shall be wired with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay may be energized at the same time on the same pair of wires.

    4. Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised, UL listed remote power supply.

    5. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.

14. Isolator Module

    1. Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on a loop Class A. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the loop segment or branch. At least one isolator module shall be provided for each set of detectors (max 19 numbers).

2. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the loop. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.

3. The isolator module shall not require any address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.

4. The isolator module shall mount in a standard 4-inch (101.6 mm) deep ELV box or in a surface mounted back box. It shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

15. **Addressable Interface Devices** shall be provided to monitor contacts for such items as conventional gas/ agent release panels, water-flow, tamper, and PIV switches connected to the fire alarm system. These interface devices shall be able to monitor a single or dual contacts. An address will be provided for each device and all physical devices shall require only one address on a signaling line circuit regardless of the number of circuits on an individual module. Where remote supervised relay is required the interface shall be equipped with a SPDT relay rated for 4 amps resistive and 3.5 amps inductive.

16. Notification Appliances:

- The Horn or horn/strobe appliance as indicated on the drawings shall be a synchronized temporal horn with a synchronized strobe light with multiple candela taps to meet the intended application. The appliance shall be red or white as indicated on the drawings. The strobe light taps shall be adjustable for 15/75, 30/75, 75, and 110 candela. The appliance shall be red for wall mounted and white for ceiling mounted. Ceiling mounted appliances shall be rated for that application.

- The electronic strobe as indicated on the drawings shall be a speaker with a tone card and have and adjustable range of 700 to 1300 Hz. The chime or chime/strobe shall be adjustable for either single stroke or continuous operation. The chime/strobe shall be available with adjustable strobe intensities of 15, 30, 75, and 110 candelas. The appliance shall be red for wall mounted and white for ceiling mounted. Ceiling mounted appliances shall be rated for that application.

17. EXECUTION

EXAMINATION

Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

Proceed with installation only after unsatisfactory conditions have been corrected.

INSTALLATION:

Surface cabling should be neatly run and securely fixed at suitable intervals in accordance with the manufacturer's recommendations.

Joints in cables, other than those within equipment enclosures should be avoided wherever possible.

Where a cable passes through an external wall it should be contained in a smooth bore sleeve of metal or other non-hygroscopic material sealed into the wall. This material will slope downwards towards the outside and should be sealed with a suitable waterproof compound.

Where cables, conduits or trunking pass through floors, walls, partitions or ceilings the surrounding hole shall be made good with a fire stopping material with sufficient fire resistance to maintain the integrity of the construction.

Each junction box will include the legend "Fire Alarm System" on its cover.

All wires shall be provided with an identifying permanent label within 25mm of its termination.

A consistent color code for fire alarm conductors will be used throughout the installation.
Wiring within enclosures will be arranged to allow accessibility to equipment for adjustment & maintenance.

BOXES, ENCLOSURES AND WIRING DEVICES

Boxes shall be installed plumb and firmly in position.

Extension rings with blank covers shall be installed on junction boxes where required.

Junction boxes served by concealed conduit shall be flush mounted.

Upon initial installation, all wiring outlets, junction, pull and outlet boxes shall have dust covers installed. Dust covers shall not be removed until wiring installation when permanent dust covers or devices are installed.

CONDUCTORS

Each conductor shall be identified as shown on the drawings at each with wire markers at terminal points. Attach permanent wire markers within 5 cm of the wire termination. Marker legends shall be visible.

All wiring shall be supplied and installed in compliance with the requirements of the ELV Code and that of the manufacturer.

All splices shall be made using solderless connectors. All connectors shall be installed in conformance with the manufacturer recommendations.

Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.

The installation contractor shall submit for approval prior to installation of wire, a proposed color code for system conductors to allow rapid identification of circuit types.
Wiring within sub panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance.

DEVICES

Wiring within enclosures will be arranged to allow accessibility to equipment for adjustment & maintenance.

All devices shall be mounted to or in a suitable ELV box.

COMMISSIONING

The entire system shall be inspected & tested to ensure that it operates in accordance with this specification and the country requirements. In particular that:

All manual call points & automatic fire detectors function correctly.

All devices carry an accurate identification label.

All manual call points and automatic fire detectors when operated result in the correct text & zone indications at all necessary indicating equipment.

That sound pressure levels meet as per requirements.

That the systems cause and effects match the requirements of this specification.

The sitting of all manual call points & automatic fire detectors meet the country requirements.

DOCUMENTATION

On completion of the system the contractor shall provide the following documentation:
Complete listings of fitted devices, their programmed parameters, texts and assignments.

Documentation of all programmed cause & effects.

Documentation of actual field wiring topology.

TRAINING

Training shall be provided as follows:

The contractor shall provide full training on system operation & user responsibilities to at least two persons nominated by the customer.

CERTIFICATION

Upon completion the contractor will provide the following certificates in accordance with the country regulation:

Design certificate.
Installation certificate.
Commissioning certificate.
Acceptance certificate.

Verification certificate.

The items/quantities shall be measured and paid upon completion of the linked milestone as per BOQ for the respective item.

16.0 VIDEO SURVEILLANCE / CCTV SYSTEM:

16.1 Scope

This specification covers the general requirements for Supply, Installation, Testing, & Commissioning of Closed-Circuit Television systems (CCTV).

16.2 IP based Indoor Fixed Dome Cameras with Built in Audio

SR No.	Parameter	Description
1	Image sensor & Minimum Effective Pixels (Resolution) or better	1/2.8" or better CMOS or Equivalent & Minimum 2 MP @25fps
2	Electronic Shutter	1/30 to 1 / 100000 s or better
3	Min illumination/ light sensitivity (Colour) or better	Minimum 0.001 lux (30 IRE, F 2.0) or better
4	Min illumination/ light sensitivity (B/W)	Minimum 0.01 lux (30 IRE, F 2.0) & 0 Lux on IR on
5	Wide Dynamic Range	Required Min. 120 dB
6	Backlight Compensation	ON/OFF
7	IR Range	Min. 15 Mtr.
8	Focus	Automatic / Manual
9	Automatic Gain Control	Auto / Manual
10	Sharpness, Brightness, Contrast	functionality Required
11	Frame Rate	25 FPS for 1920 x 1080 at H.265 Compression or better
12	Fixed Lens	2.8 mm/ 4 mm/ 6mm fixed lens as per site requirement
13	Video	
	Day and Night functionality	Automatic, Color, Mono
	Video Resolution	Minimum 2 MP @25fps
	Video Streams	Individually configurable 02 video streams (H.265, MJPEG)
	Intelligent Video	Motion detection, Tampering Alert
14	Compression	
	Dual H.264 (Recording & Viewing)	Required, Live stream 1080p should support min. 50/60 FPS and recording at lower resolution and frame rate or vice versa as may be configured.
15	**Audio**	
	Audio support	Built in Audio/ Mic
	Audio Compression	Minimum G.711 or better AAC48KHz or better
	Two-way audio	Required
	Input / Output	01 IN & 01 OUT
16	**Network & Interface**	
	Interface	RJ-45 for 10/100 base-T Ethernet
	Upgrade	Through web browser , online, firmware upgrade
	Network Protocols support	IPv4, IPv6, TCP/IP, HTTP, , DHCP, UDP, DNS, SMTP, RTP, RTSP, SNMP, UpnP, NTP, ICMP, IGMP,

SR No.	Parameter	Description
	Alarm Event	Events / alerts send via FTP, HTTP, email, post-alarm video buffering.
	Alarm I/O	1 potential Free 1 In & 1 Out
	Compliance	ONVIF Profile S or betterB39
17	**Security**	
	Password Protection	Required
	HTTPS encryption	Required
	IEEE 802.1X	Required
	Cyber Security Certification	PCI-DSS or equivalent
18	**General**	
	Operational temperature °C	0°C to 50 °C
	Humidity	0 to 80% RH non-condensing
	IP rating	IP67, IK10
	Power	PoE (Up to 15.4 Watt) OR eAC24V/ DC12V, 100-230VAC
	Certifications	CE, FCC, UL and BIS
	SD card	Camera should support SD card up to 128 GB and the bidder shall provide a data card of 128 GB with the device. In the event of failure of connectivity to the central server the camera shall record video locally on the SD card automatically. After the connectivity is restored these recordings shall be automatically merged or can be merged manually as & when required with the server recording such that no manual intervention is required to transfer the SD card based recordings to server.

16.3 IP based Indoor Fixed Dome Cameras without Audio

SR No.	Parameter	Description
1	Image sensor & Minimum Effective Pixels (Resolution) or better	1/2.8" or better CMOS or Equivalent & Minimum 2 MP @25fps
2	Electronic Shutter	1/30 to 1 / 100000 s or better
3	Min illumination/ light sensitivity (Colour) or better	Minimum 0.05 lux (30 IRE, F 1.4) or better
4	Min illumination/ light sensitivity (B/W)	Minimum 0.01 lux (30 IRE, F 1.4) & 0 Lux on IR on
5	Wide Dynamic Range	Required
6	Backlight Compensation	ON/OFF
7	IR Range	20-30 Meter
8	Focus	Automatic / Manual
9	Automatic Gain Control	Auto / Manual
10	Sharpness, Brightness, Contrast	functionality Required
11	Frame Rate	25 FPS for 1920 x 1080 at H.264 Compression or better
12	varifocal Lens	2.8 mm to 12 mm Motorized Varifocal

SR No.	Parameter	Description
13	Video	
	Day and Night functionality	Automatic, Color, Mono
	Video Resolution	Minimum 2 MP, @25fps
	Video Streams	Individually configurable 02 video streams (H.265, MJPEG)
	Intelligent Video	Motion detection, Tampering Alert
14	Compression	
	Dual H.264 (Recording & Viewing)	Required, Live stream 1080p should support min. 25 FPS and recording at lower resolution and frame rate or vice versa as may be configured.
15	**Audio**	
	Audio support	Required
	Audio Compression	Minimum G.711 or better AAC48KHz or better
	Two-way audio	Required
	Input / Output	01 IN & 01 OUT
16	**Network & Interface**	
	Interface	RJ-45 for 10/100 base-T Ethernet
	Upgrade	Through web browser , online, firmware upgrade
	Network Protocols support	IPv4, IPv6, TCP/IP, HTTP, , DHCP, UDP, DNS, SMTP, RTP, RTSP, SNMP, UpnP, NTP, ICMP, IGMP,
	Alarm Event	Events / alerts send via FTP, HTTP, email, Pre-Post alarm video buffering.
	Alarm I/O	1 potential Free 1 In & 1 Out
	Compliance	ONVIF Profile S or betterB39
17	**Security**	
	Password Protection	Required
	HTTPS encryption	Required
	IEEE 802.1X	Required
	Cyber Security Certification	PCI-DSS or equivalent
18	**General**	
	Operational temperature °C	0°C to 50 °C
	Humidity	0 to 80% RH non-condensing
	IP rating	IP66, IK10
	Power	PoE (Up to 15.4 Watt) OR eAC24V/ DC12V, 100-230VAC
	Certifications	CE, FCC, UL and BIS
	SD card	Camera should support SD card up to 128 GB and the bidder shall provide a data card of 128 GB with the device. In the event of failure of connectivity to the central server the camera shall record video locally on the SD card automatically. After the connectivity is restored, these recordings shall be automatically merged or can be merged manually as & when required with the server recording such that no manual intervention is required to transfer the SD card based recordings to server.

16.4 IR Veri-Focal Bullet Camera

SR No.	Parameter	Description
1	Image sensor & Minimum Effective Pixels (Resolution) or better	1/2.8" or better CMOS or Equivalent & Minimum 2 MP @25fps
2	Electronic Shutter	1/30 to 1 / 100000 s or better
3	Min illumination/ light sensitivity (Colour) or better	Minimum 0.01 lux (30 IRE, F 1.6) or better
4	Min illumination/ light sensitivity (B/W)	Minimum 0.01 lux (30 IRE, F 1.6) or better
5	Wide Dynamic Range	120 dB or higher required
6	Backlight Compensation	ON/OFF
7	Lens	2.8-12mm Motorized Vari-focal DC-IRIS or Automatic.
8	Focus	Automatic / Manual
9	Automatic Gain Control	Auto / Manual
10	Sharpness, Brightness, Contrast	functionality Required
11	Frame Rate	25 FPS for 1920 X 1080 at H.265 Compression or better
12	**Video**	
	Day and Night functionality	Automatic, Color, Mono
	IR illuminator	Illuminator may be Internal or external & visibility should be at least 50 m
	Video Resolution	Minimum 2 MP (1920 x 1080)
	Video Streams	Individually configurable 03 video streams (H.265, H.264, MJPEG)
	Intelligent Video	Motion detection, Tampering Alert, Face Detection/ Audio Detection/ Tripwire/ Intrusion/ Object Abandoned/ Object Missing/ Trigger line/loitering
13	**Compression**	
	H.265/H.264/MJPEG (Recording & Viewing)	Required, Live stream 1080p should support min. 50 FPS and recording at lower resolution and frame rate or vice versa as may be configured.
14	**Audio**	
	Audio support	Required
	Audio Compression	Minimum G.711 or better AAC48KHz or better
	Two-way audio	Required
	Input / Output	01 IN & 01 OUT
15	**Network & Interface**	
	Interface	RJ-45 for 10/100 base-T Ethernet
	Upgrade	Through web browser , online, firmware upgrade
	Network Protocols support	IPv4, IPv6, TCP/IP, HTTP, , DHCP, UDP, DNS, SMTP, RTP, RTSP, SNMP, UpnP, NTP, ICMP, IGMP,
	Alarm Event	Events / alerts send via FTP, HTTP, email, Pre-Post alarm video buffering.

SR No.	Parameter	Description
	Alarm I/O	1 potential Free 1 In & 1 Out
	Compliance	ONVIF Profile S or betterB39
16	**Security**	
	Password Protection	Required
	HTTPS encryption	Required
	IEEE 802.1X	Required
	Cyber Security Certification	PCI-DSS or equivalent
17	**General**	
	Operational temperature °C	0°C to 50 °C
	Humidity	0 to 80% RH non-condensing
	IP rating	IP67, IK10
	Power	PoE (Up to 22.4 Watt) OR eAC24V/ DC12V, 100-230VAC
	Certifications	CE, FCC, UL and BIS
	SD card	Camera should support SD card up to 128 GB and the bidder shall provide a data card of 128 GB with the device. In the event of failure of connectivity to the central server the camera shall record video locally on the SD card automatically. After the connectivity is restored these recordings shall be automatically merged or can be merged manually as & when required with the server recording such that no manual intervention is required to transfer the SD card based recordings to server.

16.5 Network Video Recorder (Channel as per BOQ)

Item No.	Features	Description
1	Type	Tower/Rack mount
2	No of channels	As per requirement
3	Number of Drives	Minimum 12xSATA II
4	Max Storage Per Drive	Maximum supported up to 12 TB
5	Max internal storage	up to 144 TB
6	RAID Level	Should support RAID 0,1, 5, 6,10
7	I/O Interface	Minimum 3 X USB 2.0 (for mouse, UPS); 1xeSATA (for DAS)
8	Voltage	100-240V
9	Power supply	1+1 750W hot plug redundant
10	OS	Windows 10 or better
11	Throughput	Supporting up to 128 channels of 2-Megapixel cameras, 250~550Mbps
12	Nos. of Camera Recording per server	Minimum 128 Nos.
13	Multiple codec support	H.264, MJPEG, MPEG4 and H.265
14	Video Output	Min 2 HDMI Outputs

15	Should Support Stream up to 64ch live viewing connections per server to multiple clients simultaneously
16	Should Support PTZ functioning, PTZ Joystick
17	Support continuous, scheduled, event based and I/O based recording
18	Schedule-based and input-triggered boosting record
19	Should support Scheduled Backup video to FTP location
20	Should support Watermark for video verification
21	Should support Dual gigabit Ethernet ports
22	Operating Temperature : 0°C-40°C
23	Humidity : Operating: 5%-95%
24	Should support 12MP Resolution Recording
25	Should have Minimum 320 Mbps Bandwidth
26	Should have support H.265/ H.264/ MPEG4
27	Powerful investigation and video archive search tools from remote client
28	Dynamic IP Camera Discovery – Automatically discover all compatible cameras connected
29	Multi-level user access rights for viewing and manages access to the functions
30	Advanced security features with encryption support for communication between desktop client to recorder and secure https login for Web Client and mobile apps
31	Should support integration with Access control system
32	Surrounding Cameras: Provide option to grant a user the ability to view a single camera surrounded by the cameras programmed as the "Surrounding Cameras"
33	The system shall support the ability to schedule recordings for each individual camera for times in the future
34	Capable of adjusting the contrast, brightness, and saturation settings for each camera independently
35	The Report facility shall include event history report and audit log report.
36	The offered VMS should support Integration with Access Control System, Fire Alarm System and should third party Video Analytics software.

16.6 55 inch Full HD LED Display

Item No.	Description Model-	Compliance Y/N
1	**55-inch Full HD LED Display**	
2	Screen Size : 55" LED Monitor, Commercial Series	
3	Aspect Ratio : 16:9	
4	Native Resolution : 1920 x 1080p	
5	Brightness : 350 cd/m2 or higher	
6	Response Time : 8ms or lower	
7	Input : HDMI x 2 RGB x 1 or more USB x 2 or more RCA x 1 or more	
8	Operating Temperature : 0oC to 40oC	
9	Operating Humidity : 20% to 90%	
10	Built in Speaker : 2 x 10W	

Item No.	Description Model-	Compliance Y/N
11	Power Supply : 100-240V~, 50/60Hz	
12	Power Consumption : Typ.: 94W or Lower	
13	Certification : IS 13252:2010	
14	Wall Mount Bracket : Required	

16.7 ABBREVIATIONS

- CCTV–Closed Circuit Television
- IEC -International Electro-Technical Commission
- CE-Conformité Européenne
- UL-Under writers Laboratories
- EN – Standards by European Committee for Standardization(CEN)
- CCD -Charged Coupled Device
- PAL-Phase Alternating Line
- MPEG -Moving Picture Experts Group
- IP-Ingress Protection
- NVR -Network Video Recorder
- HDD -Hard Disk Drive
- JPEG – Joint Photographic Experts Group
- PTZ-Pan, Tilt, Zoom
- POE –Power Over Ethernet

The items/quantities shall be measured and paid upon completion of the linked milestone as per BOQ for the respective item.

17.0 PUBLIC ADRESS SYSTEM:

17.1 System Design Requirements

17.1.1 The voice alarm system shall be the integrated solution for EVAC. The voice alarm system shall be designed for public address and emergency evacuation. All the essential EVAC functionality– such as system supervision, spare amplifier switching, loudspeaker line surveillance, digital message management and a fireman's panel interface – shall be combined.

17.1.2 The system shall provide for emergency call (EMG), business call and, up to 5 zones, 8 call stations and two remote control panels. The voice alarm system shall be a one channel/two channel system. It shall be compatible with BGM and 100 V booster

amplifiers. It shall be capable of connecting to EVAC compliant loudspeakers and accessories for an integrated public address and voice alarm solution.

17.1.3 The system shall be fully IEC 60849 compliant. It shall have full system supervision, loudspeaker line impedance supervision, a supervised emergency microphone on the front panel and a supervised message manager for 255 pre-recorded messages and chimes. It shall be possible to merge messages to allow even more flexible use of pre-recorded announcements and evacuation messages. It shall be possible for each message to have any length within the total available capacity. The memory shall have a capacity of 16 MB. It shall be possible to upload from a PC via USB into the memory, after which the unit shall operate without PC connection. The standard WAV-format shall be used for the messages and sample rates of 8kHz up to 24kHz with 16-bit word length (linear PCM) shall be supported.

17.1.4 Volume override relay contacts shall be provided for each zone separately for overriding local loudspeaker volume controls. All current override schemes shall be supported (3-wire and 4-wire override schemes i.e. standard 24V and failsafe). Upon a call or an activated trigger input these contacts shall be activated for the appropriate zones, together with an additional voltage free contact (Call Active) for control purposes.

17.1.5 A 24Vdc output shall be available to supply power to external relays, so no external power supply shall be required for that purpose. A LED VU-meter shall allow for monitoring of the master output.

17.1.6 The maximum allowed total cable length between the controller and the last router in the chain shall be 1000 meters. The maximum allowed total cable length between the controller and the last call station in the chain shall be 1000 meters. The maximum allowed total cable length between the controller and the RC panel shall be 1000 meters.

17.2 Device Description

17.2.1 Digital Integrated System Manager / controller

A Features

The Controller should have the following Features and Functions: -

- Should support minimum Fifteen-zone with zone expandable routers
- Business and emergency control inputs
- The controller should be EN 54-16 and EN 60849 compliant

B Functions

- The controller should have two BGM source inputs and a mic/line input with configurable priority, speech filter & phantom power. The controller should have 16 priority levels can be specified for microphone, call stations and trigger inputs for optimum system flexibility.

- Configuration software should be provided on the CD included with the unit. The CD shall also include other useful programs, such as MP3-ripping software, a sample-rate converter, various audio and visual tools, and free, MP3-coded music.

- A separate 100 V call-only output provides addressing for an area where BGM is not required but where priority announcements are necessary. Six

configurable volume-override output contacts should be available for overriding local volume controls during priority calls. The Controller should support both four-wire and three-wire schemes. There should be LED meter for monitoring the output.

- The Controller should support storage of 255 messages internal 8/16/32 MB Flash ROM, without a need for battery backup. Message can have any length within the total available capacity. Messages and configurations should be uploaded from a PC via USB 2 into the memory, after which the unit operates without a PC connection. The messages should be in standard WAV format and sample rates of 8 kHz up to 24 kHz with 16-bit word length (linear PCM) which would give upto 17 minutes of recording time with CD-quality signal-to-noise ratio.

- The unit should have 12 contact trigger inputs for business and emergency (EMG) calls. Each input shall be configured for a message consisting of a sequence of up to eight wave files. It shall be possible that some wave files may be used in various combinations with other messages, optimizing flexibility and the amount of storage space used. Controller should have facility of multiple messages merged to form one integrated message.

C Technical Specifications:

ELV	
Mains Power Supply	
Voltage:	230/115VAC, ±15%, 50/60 Hz
Current inrush:	8 A
Max power consumption:	600 VA
Battery power supply	
Voltage:	24 VDC, +15% / -15%
Current max:	14 A
Performance	
Output power (rms/maximum):	240 W / 360 W
Power reduction on backup power:	-1 dB
Frequency response:	60 Hz to 18 kHz (+1/-3 dB at -10 dB ref. rated output)
Distortion:	<1% at rated output power, 1 kHz
Bass control:	-8/+8 dB at 100 Hz
Treble control:	-8/+8 dB at 10 kHz
Mic/line input:	1 x
Connector:	XLR, 6.3 mm jack
Sensitivity:	1 mV (mic), 1 V (line)
Impedance:	>1 k ohm (mic); >5 k ohm (line)

S/N (flat at max volume:	>63 dB (mic); >70 dB (line)
S/N (flat at min volume/muted):	>75 dB
CMRR:	>40 dB (50 Hz – 20 kHz)
Headroom:	>25 dB
Speech filter:	-3 dB at 315 Hz, high-pass,6 dB/oct
Phantom power supply:	12 V (mic mode only)
VOX trigger level:	-20 dB (100 µV mic / 100 mV line) or via input contact
Limiter:	Automatic
Line input:	(BGM and PC call station)
Connector:	Cinch, stereo converted to mono, unbalanced
Sensitivity:	200 mV
Impedance:	22 kohm
Loudspeaker outputs	
Connectors:	MSTB 2,5 /16-ST, floating
100 V output:	700 W rated per zone
Volumes override types:	3-wire, 4-wire (24 V), 4-wire failsafe
BGM zone output: Attenuation	70 / 50 /35 /25 / 18 / 13 V for 0 / -3 / -6 / -9 / -12 / -15 dB 120 / 60 / 30 / 15 / 8 /4 W
Power consumption	
Mains operation	
Max power:	550 W
-3dB:	440 W
-6dB:	340 W
Pilot tone*:	136 W
Idle:	60 W
24 VDC operations	
Max power:	14.0 A (336 W)
-3 dB:	12.5 A (300 W)
-6 dB:	9.5 A (228 W)
Pilot tone:	2.5 A (60 W)
Idle:	0.9 A (22 W)
Mechanical	
Dimensions (H x W x D):	144 x 430 x 370 mm (19" wide, 3U high)
Weight:	Approx. 21.17 kg
Mounting:	19"rack
Color:	Charcoal
Environmental	
Operating temperature:	-10 °C to +55 °C (14 °F to +131 °F)
Storage temperature:	-40 °C to +70 °C (-40 °F to +158 °F)

Relative humidity:	<95%
Acoustic noise level of fan:	<48 dB SPL at 1 m (max output)

17.2.2 120/240/480-Watt Power Amplifier

A Features:

- The amplifier should be of **120/240/480** rated amplifier
- It should support 70V / 100V and 8 ohm outputs.
- Should support Dual inputs with priority switching.
- 100 V input for slave operation on 100 V speaker line.
- Temperature controlled forced front to back.
- Mains, battery back-up, and pilot tone supervision
- EN 54-16 and EN 60849 compliant.

B Functions:

- The unit should operate both on mains power and on a 24 V battery power supply for emergency backup, with automatic switchover.
- A temperature-controlled fan should be provided for ensuring high reliability at high output levels and low acoustic noise at lower output levels. An overheat protection circuit switch should be provided for off the power stage and activates an LED on the front panel, if the internal temperature reaches a critical limit due to poor ventilation or overload.
- For emergency and evacuation use, the following functions should be monitored: mains presence, battery present, pilot tone presence, amplifier operation. Front panel LEDs indicate the status of supervised functions.
- The LEDs of pilot tone supervision and battery status can be switched off for general public address use. Failsafe (normally energized) relays are provided for each supervised function. These relays are always active regardless of the switches on the rear panel.

Inputs: -

- The system should have two balanced inputs with priority control, each with a loop-through facility, which would make it easy to connect remote systems that require priority control. An additional 100 V line input should be provided to connect the amplifier to a 100 V loudspeaker line, to provide more power to remote locations.
- Gain or level control must be located on the rear of the unit to avoid accidental setting change. A meter with LED-bar shows the output level.

Output: -

- The amplifier should have 70 V and 100 V outputs for constant voltage loudspeaker systems and a low impedance output for 8-ohm loudspeaker loads.

- The Power Amplifier should have two separate priorities controlled 100 V outputs for zones that only need announcements made via the priority input, and for zones that will not get any announcements made via the priority input.

C Technical Specifications:

ELV	
Mains Power Supply	
Voltage:	230/115VAC, ±15%, 50/60 Hz
Current inrush:	8 A
Max power consumption:	400 VA
Battery power supply	
Voltage:	24 VDC, +15% / -15%
Current max:	6A
Performance	
Output power (rms/maximum):	**120W/ 240W / 480W**
Power reduction on backup power:	-1 dB
Frequency response:	50 Hz to 20 kHz (+1/-3 dB @ -10 dB ref. rated output)
Distortion:	<1% @ rated output power, 1 kHz
S/N (flat at max volume):	>80 dB
Line input:	**3**X
Connector:	3-pin XLR, balanced
Sensitivity:	1V
Impedance:	20 kohm
CMRR:	>25 dB (50 Hz to 20 kHz)
Gain:	40 dB
100 V input	
Connector:	Screw, unbalanced
Sensitivity:	100 V
Impedance:	330 kohm
Line loop-through output:	2X
Connector:	3-pin XLR
Nominal level:	1 V
Impedance:	Direct connection to line input
Loudspeaker outputs:	3X
Connector:	Screw, floating
Direct output:	100 V, 70 V, 8 ohm
Priority only (from input 1):	100V or 70 V internally selectable
Music (non-priority) only:	100V or 70 V internally selectable
Power consumption:	
Max power:	990 W
-3dB:	715 W
-6dB:	510 W
Pilot tone:	110 W
Idle:	25 W

24 VDC Operations	
Max power:	32 A (770 W)
-3 dB:	26 A (625 W)
-6 dB:	18 A (430 W)
Pilot tone:	3.8 A (91 W)
Idle:	0.7 A (17 W)
Mechanical:	
Dimensions (H x W x D):	100 x 430 x 270 mm
Weight Approx.:	10.5 kg
Mounting Standalone:	19"rack
Environmental:	
Operating temperature:	-10 °C to +55 °C (14 °F to +131 °F)
Storage temperature:	-40 °C to +70 °C (-40 °F to +158 °F)
Relative humidity:	<95%
Acoustic noise level of fan:	<45 dB SPL @ 1 m (max output)

17.2.3 Call Station/ Paging Console

The call station shall be provided for making a manual or pre-recorded call to any pre-assigned zones or executing a predefined action. The call station shall have one key. The call station shall have a fixed microphone to transmit speech over the network and a press-to-talk key. The call station shall also have a headset socket. Once the headset is connected the microphone will be muted. The unit shall be certified to be compliant to IEC60849 and compliant to other relevant local standards.

a) The call station shall have a speech filter with a cut-off frequency at 340Hz to improve intelligibility and prevent clipping of the audio input on low-frequency signals.

b) The call station unit shall support connection with at least 6 call station keypad units via serial data communication links. should have minimum 2 nos. of 6 call station keypad from day 1.

c) The power supply to the call station keypad units shall be provided from the call station.

d) The call station shall have a volume control for the monitoring loudspeaker at the call station. The volume control shall also control the volume of the headset.

e) The call station shall be programmable for momentary actions on make contact and toggle actions without repeat on make contact.

f) It shall be possible to assign 256 priorities.

g) Analogue-to-digital audio conversion shall be performed at the call station itself.

h) The call station shall also have a digital signal processor, which can be used for audio processing. It can be used to adjust sensitivity, limiter and parametric equalizer.

i) The monitoring loudspeaker shall be on when that particular call station activates a chime or pre-recorded message and will be switched off when its own live audio channel is open.

Interfaces

a) System network connection

b) Serial data and power supply interfaces for call station keypad units
c) Headset socket

Number of connectors: 1
Position: Front
Type: 3.5 mm jack
Maximum cable length: 1.5m
Audio: Mono microphone signal, mono earphone signal

Indications and controls

- The call station must have three 2-color LEDs for the following indications:

  Power on and no system/call station fault

  Power not available

  Fault in the system and power on

  Call station fault and power on

  Chime on or pre-recorded message playing

  Ready to talk/live speech

  No call status to display

  Emergency announcement is on in the system. Possible to make normal calls to the zones which are not involved (emergency) indication has priority over other indications)

- Lower-priority calls are on or reserved (to all or some of the pre-assigned zones of the PTT key of the call station and selected zones of the call station keypad unit if installed)

- Calls with higher or the same priority (not emergency) are on or reserved (to all or some of the pre-assigned zones of the PTT key of the call station and selected zones of the call station keypad unit if installed)

- No predefined or selected zones are in use or reserved by the system, nor is an emergency announcement being made

- Volume control for loudspeaker/headset

17.2.4 Voice Zone Expander or Router.

- Should have capability to expand the voice alarm system with six zones.

- Should have Minimum Six volume override output contacts.

- It should provide dual channel operation for calls and BGM simultaneously to a maximum of six different zones, using amplifiers.

- It should have set of relays for zone-switching the power amplifier output(s) to different loudspeaker groups. Each zone can be switched between:
  The call channel (call-station selection, all-call microphone, or emergency activation)
  The BGM channel (front panel selection)

- Interface requirements: Min 12Nos. of Speaker Output, Min Two external amp inputs, Call output, Rs232 Control port, System Cascading port, Min two external amp outputs.

- Controls and indicators: Eight system fault LEDs, 12 EMG call-zone status LEDs, Six BMG zone selector buttons, Six EMG call-zone selection buttons.

- ELV: Mains power supply - Voltage 230/115 VAC, ±10%, 50/60 Hz
  Max power consumption 50 VA

- Trigger Inputs 12 x (6 EMG, 6 business), Connectors MC1,5 / 14-ST-3,5, Activation Programmable, Supervision On EMG inputs, programmable, Supervision method Series / parallel resist

- 100 V input: Amp 1 100 V / 70 V / 0 V, Amp 2 100 V / 0 V, Power handling capacity 1000 W.

- Loudspeaker outputs 12 x (2 x 6 zones), 100 V output 700 W rated per zone, Volume override types 3-wire, 4-wire (24 V), 4-wire failsafe

- Environmental: Operating temperature -10 °C to +55 °C (14 °F to +131 °F)

- Storage temperature -40 °C to +70 °C (-40 °F to +158 °F)

- Relative humidity <95%

17.2.5 Volume Controllers

Volume Controllers have the following four types: 6W, 30W, 60W and 120W respectively. The features are as follows:

- Build-in 24V DC forced cut-off relay;
- 5 volume levels control;
- Applicable to 3-wire, 4-wire and 6-wire systems;
- Standard 86X86 installation base-shell.

Parameters	Values
Rated power	6W/30W/60W/120W
Supply voltage	100V
Frequency response	50Hz~20KHz
Attenuation	5X2dB + off
Current consumption	20mA, 24V DC

Audio source

The Integrated CD player supports the MP3 music files on removable disks, SD cards, DAB digital broadcastings and FM tuners.

- Two single CD\USB\SD and DAB\FM line outputs can play music applications in two areas.
- The volumes of the two line outputs can be adjusted separately.
- CD\USB\SD has three play modes: single play, all play and repeated play.

17.2.6 Ceiling Speaker

- 6W Ceiling speaker with metal grille and 6/3W taps

Parameters	Values
Max power	8W
Rated power	6W
Power taps @ 100V	6W / 3W
Sound pressure level at 6W/1W (1kHz,1m)	105 dB / 90 dB
Frequency range (-10dB)	150 Hz -15 kHz
Dispersion angle (1kHz/-6dB)	Minimum 160°
Rated input voltage	100 V / 70 V
Rated impedance	1.5 KΩ
Connection	Two Wire Cable or Equivalent
Dimensions (Φ x H)	As per OEM
Hole cut-out size	As per OEM
Size of speaker	As per OEM
Weight	As per OEM
Color	White (RAL 9010)
Weight of Magnet	As per OEM

17.2.7 Wall Mount Cabinet Speaker

- 30W Wall mount speaker with 30/15/10/5W taps

Parameters	Values
Rated Power	30 W
Maximum Power	45 W
Power taps @ 100V	30/15/7.5/3.75 W
Sound pressure level at Rated Power /1W (1kHz,1m)	Minimum 105 dB / 90 dB
Frequency range (-10dB)	100 Hz - 18k Hz
Rated impedance	8 ohm
Connection	Two Wire cable
Dimensions (W x H x D)	As per OEM
Weight	As per OEM
Color	White (RAL 9010)
Weight of Magnet	As per OEM
Operating temperature	-25 °C to +55 °C (-13 °F to +131 °F)
Storage temperature	-40 °C to +70 °C (-40 °F to +158 °F)
Relative humidity	<95%

17.2.8 2-CORE 1.5 SQ MM ARMORED 1-PAIR TWISTED LS CABLE

For connecting loudspeakers from power amplifier to power amplifier for zone wise as per tender specification.

17.3 Training

- Train the clients to know the system structure and principles.
- Train the clients to know and master the installation methods of the digital broadcasting systems.
- Train the clients to master the configuration methods of the digital broadcasting systems.
- Train the clients to use digital broadcasting system software.
- Train the clients to know basic troubleshooting and maintenance methods of the digital broadcasting systems.
- **The items/quantities shall be measured and paid upon completion of the linked milestone as per BOQ for the respective item.**

MAKE OF MATERIAL-ELECTRICAL

SR.NO.	ITEM	STANDARD MAKE
1	COMPACT SUBSTATION WITH OIL TYPE TRANSFORMER	VOLTAMP / SCHNEIDER / SUDHIR POWER / ABB / POWER LITE / MEGHAVOLT POWER
2	LT PANELS (CPRI Certified)	SHIV SHAKTI ENGINEERS / ADVANCE PANEL / HITECH ENGINEERS / ACTIVE ENGINEERS / ADISHWARAM CORPORATION TENCOGROUP / JJ INDUSTRIES
3	DIESEL ENGINE	CATTERPILLER / CUMMINS INDIA/ PERKINS / KIRLOSKER / GREAVES / VOLVO PENTA
4	ALTERNATOR	STAMFORD / KIRLOSKAR / CROMPTON GREAVES / LEROY SOMER
5	SYNCHRONISING RELAY	WOOD WARD EASY GEN 3200 / STUKE / DEIF / DEEP SEA / EMCP-2 / GC 500
6	DISTRIBUTION BOARDS	LEGRAND - EKINOXE / SCHNEIDER - ACTI9 / HAGER/ LAURITZ KNUDSEN (L&K) / ABB /PANASONIC / SIEMENS
7	MEDIUM VOLTAGE CABLE	FINOLEX / POLYCAB / GLOSTER / KEI/AVOCAB/RR KABLE
8	CABLE TRAY (LADDER TYPE / PERFORATED)	OBO BETTERMANN / LEGRAND /DUDHAT / PROFAB / BILMAT
9	CABLE TRAY SUPPORT	MUPRO / FISCHER / HILTI
10	UPS	NUMERIC / SCHNEIDER / EATON /VERTIV
11	SPD (SURGE ARRESTER)	PHEONIX CONTACT / OBO / LEGRAND / SCHNEIDER / ABB
12	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
13	LT SWITCHGEAR (MCCB)	LEGRAND – DRX / SCHNIEDER - CVS / LAURITZ KNUDSEN (L&K) – D SINE /ABB – TMAX / SIEMENS-3VJ
14	LT SWITCHGEAR (MCB)	LEGRAND - DX3 / SCHNIEDER – ACTI 9 / LAURITZ KNUDSEN (L&K)-AU /PANASONIC/ABB/HAGER/ SIEMENS-5TJ
15	LT SWITCHGEAR (CONTACTOR, RELAY, MPCB)	LEGRAND - CTX3/MPX3/RTX3/SCHNEIDER/LAURITZ KNUDSEN (L&K)/SIEMENS/ABB
16	METERS (ANALOG)	RISAHBH/SCHNEIDE/AE/ELMEASURE/NIPPEN/SECURE
17	METERS (DIGITAL)	AE/SCHNEIDER/LAURITZ KNUDSEN (L&K)/ELMEASURE/NIPPEN/SECURE/LEGRAND PMX
18	ENERGY METER	SCHNEIDER/LAURITZ KNUDSEN (L&K) /NIPPEN/ELMEASURE/SECURE/LEGRAND
19	LOAD MANAGER	SCHNEIDER / LAURITZ KNUDSEN (L&K) /NIPPEN/ELMEASURE / LEGRAND
20	INDICATING LAMPS	SCHNEIDER / LAURITZ KNUDSEN (L&K) / SALZER
21	ELECTRIC TIMER	LEGRAND / LAURITZ KNUDSEN (L&K) / LEGRAND / SCHNEIDER / SIEMENS / ABB
22	ROTARY SWITCH	KEYCEE / SALZER

MAKE OF MATERIAL-ELECTRICAL

SR.NO.	ITEM	STANDARD MAKE
23	PUSH BUTTON AND PUSH-BUTTON SET	SCHNEIDER ELECTRIC / LAURITZ KNUDSEN (L&K) / LEGRAND / C&S / ABB
24	SELECTOR SWITCH	KEYCEE / SALZER / MECO
25	APFC PANEL & RELAY	LEGRAND / EPCOS / SCHNEIDER / Lauritz Knudsen (L&K) / SUBODHAN / VISHAY / SHREEM / NEPTUNE DUCATI
26	LT CAPACITORS	LAURITZ KNUDSEN (L&K) / EPCOS / LEGRAND / SCHNEIDER/VISHAY
27	LUGS	DOWELL'S / 3D / HEX JAINSON / COMET / HMI
28	BIMETALLIC LUGS	HMI / HEX / CONNECT / Dowells
29	CABLE GLAND	3D / COMET / HMI/POLYCAB / Dowells
30	PVC CONDUITS AND ACCESSORIES	PRECISION / ASTRAL / POLYCAB/AKG/ANCHOR/BBC
31	M.S. CONDUIT AND ACCESSORIES	AKG / BEC / STEELCRAFT
32	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
33	METAL CLAD SOCKET WITH MCB	LEGRAND / HENSEL / SCHNEIDER / SCAME / SPELSBERG
34	PVC TAPE	STEEL GRIP / ANCHOR
35	PVC JUNCTION BOX	HENSEL / CLIPSAL / SPELSBERG / SCAME / SINTEX
36	WIRES FOR INTERNAL WIRING	FINOLEX / HAVELLS / POLYCAB / RR KABEL /ANCHOR / AKG / GLOSTER / KEI / RAJNIGANDHA
37	CONNECTORS (COLOURS AS PER PHASE & NEUTRAL)	WAGO / PHOENIX CONTACT/ CONNECTWELL
38	LED LIGHT FIXTURES	PHILIPS / WIPRO/ PANASONIC / JAQUAR / QLITE / KLITE
39	OUTDOOR DECORATIVE LIGHT LUMINAIRE	PHILIPS / WIPRO / BAJAJ/HAVELL'S / PANASONIC / JAQUAR / K LITE / NERI
40	CONTROL TRANSFORMER [PT / CT]	ASHMOR / AE / VIRAT / NARMADA / NEWTEK
41	CEILING FAN / EXHAUST FAN	CROMPTON / BAJAJ / ORIENT / HAVELLS
42	FIRE EXTINGUISHER	CEASEFIRE / KANEX / SAFEX / MINIMAX
43	CHEMICAL EARTHING	CAPE / OBO/ JEF / DEHN / AXIS
44	LPS	CAPE / OBO/ JEF / DEHN / AXIS
45	UP TO 33 KV VCB	SCHNEIDER / ABB/LAURITZ KNUDSEN (L&K)/SIEMENS
46	MICROPROCESSOR RELAY & OTHER HT RELAY	SCHNEIDER / ABB / MICOM P111 / SIEMENS 7SJ12
47	ANNUCIATOR	LEGRAND / Lauritz Knudsen (L&K) / ABB / MINILAC
48	UP TO 33 KV HT CABLE	FINOLEX / POLYCAB / KEI/AVOCAB/GLOSTER

MAKE OF MATERIAL-ELECTRICAL

SR.NO.	ITEM	STANDARD MAKE
49	UP TO 33 KV HT END TERMINATION KIT	RAYCHEM / 3M / RPG
50	DC BATTERY CHARGER	CHHABI / HBL
51	SMF BATTERY	EXIDE / AMARARAJA / ROCKET / AMARON
52	SOLAR PV CELLS	CANADIAN SOLAR / SONALI / ZINCO / WAREE / BOSCH / ADANI
53	GRID TIE INVERTER	HITACHI / ABB / BOSCH / TATA / DELTA / SMA
54	ANCHOR FASTENER	HILTI / 3M / MUPRO / WURTH / FISCHER
55	DWC PIPE	ALCORR / ASTRAL / DUTRON
56	RUBBER MATT - ISI MARK	JYOTI / MARUTI
57	ANTI-VIBRATION MOUNTING	DUNLOP / GERB / RASISTOFLEX OR EQUIVELANT
58	Fire Stopper / Mortar	Hilti, OBO, WURTH, FISCHER
59	Fire Stop Sealant / Foam	Hilti, OBO, WURTH, FISCHER
60	Fire Resi Cable Coating	Hilti, OBO, WURTH, FISCHER
61	LIGHT POLE	BAJAJ / KLITE / VOLMONT

MAKE OF MATERIAL-ELV

SR.NO.	ITEM	STANDARD MAKE
1	CCTV SYSTEM	TYCO / BOSCH / MOBOTIX / HONEYWELL
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