HSCC (India) Limited
as Executing Agency on behalf of
MINISTRY OF HEALTH & FAMILY WELFARE, NEW DELHI

TENDER

FOR

External Electrical Works for All India Institute of Medical Sciences (AIIMS) at Mangalagiri Distt. Guntur (AP)

under

Pradhan Mantri Swasthya Suraksha Yojana (PMSSY)

VOLUME – IV
Technical Specifications

SEPTEMBER' 2018

Executing Agency

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Tender No. HSCC/PMSSY/AIIMS/Guntur/Ext-Elect/2018

TECHNICAL SPECIFICATIONS

1. GENERAL:

These special conditions are meant to amplify the specifications and General Conditions of Contract. If any discrepancy is noted among these Special Conditions, General Conditions of Contract, Specifications, Schedule of Quantities and Drawings, the most stringent of the above shall apply, should there by any ambiguity or inconsistency, the contractor should report the same to the Architect/ Project Manager/ Owner and obtain clarification before submitting the tender. Contractor to collect General Conditions of Contract and Schedule of Fiscal Aspects from the Owner/ project manager/ architect.

2. SCOPE OF WORK:

The work to be carried out under this contract comprises of internal and external electrical installation of the project as called in the tender documents. The Electrical Contractor shall include for the supply of the whole of the materials in accordance with the Specifications and the whole of the work of fixing necessary for the complete installation as set out in these Specifications and with the accompanying schedule and drawings, commencing from the supply authority's terminals. This also include any material, appliances, equipment not specifically mentioned herein or noted on the drawings as being furnished or installed but which are necessary and Customary to make the installation complete in all respects. In general the work to be performed under this contract shall comprise supply, installation, testing & commissioning of the following:-

a. 33/11KV Transformers, HT VCB Panels & HT DG Sets with their HSD tanks & HT Cables.
b. Mains and sub-mains between various distribution boards, cables, cable trays, Rising Mains & Bus Ducts.
c. Distribution Boards, Panels, meter boards & final DB's.
d. UPS.
e. Earthing system..
f. External Lighting & Feeder Pillars.
g. CCTV System.
h. Outdoor PA & EPABX System.
i. Building Management System
j. Boom Barrier System.
k. Stage light and stage curtain for Auditorium
l. Training of owner's staff/ representative.
m. Preparation of "As Built Drawings & Documents".
n. Testing and commissioning of all electrical installations.
o. Any other items/ works required for the completion of electrical work.
p. Enhancement/Sanctioning Electrical Load from State Electricity Board.
q. Submission of GA drawings of electrical equipments and getting approvals from Client/HSCC/Owner before manufacturing/fabrication.
r. Obtaining approvals from Chief Electrical Inspectors, Local Electricity Supply Authority, Telecom Department, and any other statutory authorities for the complete scope.
s. Contractor shall submit equipment drawing from manufacturer along with the layout etc. and working drawings for approval from HSCC Electrical Engineer before manufacture / commencement of work at site.
t. Contractor has to submit the working drawing of internal & external electrification based on our tender drawings for the approval of HSCC Electrical Engineer before commencement of work.

u. If, details of any electrical item/ system are left out, then kindly refer the CPWD specifications & approval from Engineer in charge.

Note:- Some items may be supplied free of cost by the owners for installation, testing & commissioning. The entire work is to be carried out with the direction of & to the satisfaction of the owner/ Project Manager/ Architect.

3. STANDARD OF WORK:

The work shall be carried out to the satisfaction of the Architect/ Consultant/ Project Manager/ Owner and in accordance with the latest regulations of the Local Electricity Supply Authority, Local chief Electrical Inspectorate, The Fire Insurance Company, insuring the building, Indian Electricity Rules and Regulations, National Building code, National Electrical code and the enclosed Specifications.

4. ABBREVIATIONS:

The following abbreviations have been used in the accompanying specifications, drawings and schedule of quantities:
RCCB stands for Residual Current Circuit Breaker
ELCB stands for Earth Leakage circuit Breaker
HRC stands for High Rupturing Capacity
G stands for gauge
GI stands for Galvanized Iron
MS stands for Mild Steel
AL stands for Aluminum

CU stands for Copper
CI stands for Cast Iron

PVC stands for Polyvinyl Chloride

A or Amp stands for Amperes.

V stands for Volts

KWH stands for Kilowatt hour

KV stands for Kilo Volts

LV stands for Low Voltage

LT stands for Low tension

HT stands for High tension

VCB stands for Vacuum Circuit Breaker

OCB stands for Oil Circuit Breaker

CSS stands for Compact Substation

VPI stands for Vacuum Pressure Impregnated

SLD stands for single line drawing/ diagram.

IEE stands for Institution of Electrical Engineers – London

IR stands for Insulation Resistance

IC stands for Iron Clad

IP stands for Ingress Protection

MCB stands for Miniature Circuit Breaker

MCCB stands for Moulded Case Circuit Breaker

MPCB stands for Motor Protection Circuit Breaker

ACB stands for Air circuit Breaker

CT stands for Current Transformer

PT stands for Potential Transformer

O/L stands for Over Load Relay

S/C stands for Short Circuit

SPP stands for Single Phasing Preventor

MV stands for Medium Voltage

SP stands for Single Pole

DP stands for Double Pole

TP stands for Triple Pole

TPN stands for Triple Pole and Neutral

FP stands for Four Pole

MDB stands for Main Distribution Board

DB stands for Distribution Board

SDB stands for Sub-Distribution Board

FDB stands for Final Distribution Board

MCC stands for Motor Control Centre

PCC stands for Power Control Centre

IS stands for Indian Standards

BIS stands for Bureau of Indian Standards

NEC stands for National Electrical Code

NBC stands for National Building Code of India

ECBC stands for Energy Conservation Building Code of India

BMS Building Management System

HVAC stands for Heating, Ventilation & Air Conditioning

NFPA stands for National Fire Protection Association of USA

PMC stands for Project Manager

SWG stands for Standard Wire Gauge

VFD stands for Variable Frequency Drive

PLC stands for Programmable Logic Controller

ATS stands for Automatic Transfer Switch
OLTC stands for On Load Tap Charger

EDO Electrically Operated Draw Out

MDO Manually Operated Draw Out

CPCB Stands for Central Pollution Control Board

BOQ Stands for Bill of Quantities (Schedule of Quantities)

5. FEES AND PERMITS:

The contractor shall obtain and pay for all fees and permits required for the installation and approval of the complete Electrical Installation. On completion of the work, the contractor shall obtain and deliver to the Architect/ Consultant/ Project Manager/ Owner, certificates of final inspection and approval by the Local Chief Electrical Inspectorate. All receipted amount shall however, be payable by the Owner on production of proof of payment.

6. SPECIFICATIONS AND SCHEDULE OF QUANTITIES:

The Specification and Schedule of quantities shall be considered as part of this contract and any work or materials shown in schedule and not called for in the specifications or vice versa, shall be executed as if specially called for in both.

7. TENDER DRAWINGS:

The tender drawings if enclosed with the tender documents are only for the purpose of guidance to the contractor. The exact level, location etc.is to be governed by the Architecture/ interior layouts. The data/ information provided in the tender drawings and documents are as exact as it could be secured, but its complete accuracy cannot be guaranteed. The drawings indicate the general arrangement and broadly suggest the extent of work and route etc. Any change required to Co-ordinate this installation with other trades will have to be made without any extra cost to the owners. The contractor will have to assume and include everything from supply of material to its execution, testing & commissioning to make the job safe & complete in all respects as per rules & regulations, building codes & govt. approving agencies.

8. GOOD FOR CONSTRUCTION DRAWINGS (GFC's):

The details and data provided in **"GFC"** drawings is as exact and correct as it could be possible but its complete accuracy and correctness is not guaranteed. Every effort is made to make the drawings as per site conditions and the requirement of building codes but the electrical contractor has to check the accuracy and adequacy of **"GFC"** drawings before start of work. The contractor must study site conditions, understand Owner's requirement and also cross-check that the GFC drawings issued meet electrical codes, electrical safety and all govt. requirements or not. Contractor must also check the electrical earthing & lightning arrestor scheme for correctness and safety. Contractor must also check electrical SLD and calculate and cross-check load balancing on the Main LT Panel's different sections, switch gear rating and all the cable sizes. The electrical equipment layout plans must be checked for electrical safety and spacings as per electrical codes & requirement.

Any short coming noted in the design & GFC drawings and any variance from National Building codes, National Electrical code, Rules & Regulations of State Chief Electrical Inspectorate & Electrical supply company must be brought to the notice of the Architect/ Consultants/ Project Manager/ Owner in writing before the start of the work. The very purpose of preparation of shop drawings by contractor is to eliminate any error/ shortcoming in the design and the GFC's drawings prepared by the consultant.

9. SHOP DRAWINGS & FINAL WORKING DRAWINGS:

The Contractor after studying the Owner's requirement, site situation & constraints, specifications, schedule of quantities, tender drawings and good for construction drawings (if available or other wise) shall prepare and submit to Architects/ Project Manager/ Owner for comments/ approval on all the shop drawings & final working drawings required for completion of full job as per National Building Code, National Electrical Code, IEEE, requirement of Local Chief Electrical Inspectorate and the local electrical supply company including Owner's requirement. The contractor shall finally be responsible and accountable to Owner for correctness, accuracy, adequacy and safety of the complete electrical installation. The process of completing "The shop drawings & Final Drawings" shall be completed quickly with in the time frame of the project without causing any delay and before starting the actual execution work. No claims for extension of time shall be acceptable due to contractor's failure to produce right shop drawings at the right time in accordance with the approved programme of deliverables. All shop drawings to be prepared on the latest Architectural/ Structural/ Interior layouts, which are to be collected by the electrical contractor from the office of the Architect/ Project Manager/ Owner.

Following Shop Drawings & Final Working Drawings necessarily need to be prepared and submitted by the contractor:

a. LIGHTING & POWER CONDUITING LAYOUTS & DB CHARTS:

Lighting & Power Conduiting layout showing route with details on number, run & size of conduits, number of wires/ circuits to be carried thru conduits, location of junction boxes & pull boxes, circuit

numbers, phase & load balancing of circuits, wire/ circuit/ point wire size sub main size. Complete DB Chart is to be submitted for each area/ Zone.

b. LV CONDUITING LAYOUTS:

Conduiting layout of LV systems such as voice/ data/ intercom, MATV, CCTV Fire detection & alarm, Paging, public address, music and access control etc. showing route, layout, size of conduits, number of wires to be carried thru conduits, location of junction boxes & pull boxes etc. to be submitted.

c. PANEL/ DISTRIBUTION BOARDS SHOP DRAWINGS:

Shop drawings/ GA drawings of all the panels/ distribution boards/ switch boards/ cabinets with SLD's and complete control wiring, power wiring and inter locking schemes and logics to be submitted.

d. HT & LT EQUIPMENT LAYOUT:

Layout plans with dimensions, clearances for Panel rooms, Substation & DG set area, Electrical rooms and LT Panel room areas.

e. BUS DUCTING LAYOUT:

Layouts of Bus ducting, its route with details of bends, fittings, supports and its co-ordination with other services.

f. RISING MAINS LAYOUT:

Layouts of Rising Mains, route with details of bends, fittings, supports and its co-ordination with other services.

g. CABLE TRAY/ TRENCH LAYOUT

Cable tray/ trench layouts with sizes of cable trays/ trenches, details on number/ run of various cables to be Laid on trays/ in trenches. Calculations showing cable tray sizing/ spacing need to be submitted with the cable tray/ trench layouts including cable tray supporting details. Complete cable schedule is also to be submitted.

h. EARTHING LAYOUT

Earthing Layout of the complete installation showing all the earth details like size of earth tapes/ wires & materials for each equipment & routing of earth tapes/ wires. Also layout of earth pits is to be submitted.

i. LIGHTNING ARRESTOR LAYOUT

Lightning Arrestor Layout showing network of horizontal & vertical conductors, down takes, test boxes & earth pits location/ layout and sizing of earth tapes etc.

j. CONTROL SCHEMES AND INTER LOCKAING

Control Schemes and Inter Lockings for linkages with other systems such as BMS, HVAC & Fire Alarm/ Paging Systems.

Drawings shall not be limited to the above only. All necessary drawings/ details required for satisfactorily execution of the job need to be included.

Electrical Contractor shall also to be Co-ordinating its drawings with other MEP Services & Site Plans before submitting to Owners/ PMC.

Approval of shop drawings shall not be considered as a guarantee of measurements or of building dimensions. Where drawings are approved, said approval does not mean that the drawings

supersede the contract requirements, nor does it in any way relieve the contractor of the responsibility or requirement to furnish material and perform work as required by the contract.

10. PRODUCT SAMPLES

Samples of the materials like conduits, accessories, switches, Sockets, wires & cables, light fixtures etc. shall be submitted to the Owners/ PMC prior to procurement. These will be submitted in two sets for approval and retention by Owners and shall be kept in their site office for reference and verification till the completion of the project.

11. MANUFACTURER'S CATALOGUES & DRAWINGS

Manufacturer's drawings, catalogues, pamphlets and other documents submitted for approval shall be in four sets. Each item in each set shall be properly labeled, indicating the specific services for which material to allow Architect/Consultant ample time for scrutiny.

12. TEST CERTIFICATES & TECHNICAL SUBMITTALS

Contractor shall submit to owners/Project manager, test certificates & technical data sheets of all the items covered in the scope of work before supply of the item.

13. MANUFACTURERS INSTRUCTIONS:

Where manufacturers have furnished specific instructions, relating to the materials used in this job and covering points not specifically mentioned in specifications & schedule of quantities, manufacturer's instructions shall be followed.

14. MATERIALS AND EQUIPMENT:

All materials and equipment shall be of the approved make and design. Unless otherwise called for only the best quality materials and equipment shall be used. The materials and equipment shall conform to relevant Indian standards. The contractor shall be responsible for the safe custody of all materials and shall insure them against theft, damage by fire, earthquake etc. A list of items of materials and equipment, together with a sample of each shall be submitted to the Architect / Consultant/ Project Manager / Owner's within 15 days of he award of the contract. Any item which is proposed as a substitute, shall be accompanied by all technical data giving sizes, particulars of materials and the manufacturer's name. At the time of the submission of proposed substitute the contractor shall state substitution be approved, all changes and substitutions shall be requested in writing and approvals obtained in writing from the Architect/Consultants/ Project Manager / Owner's.

15. TOOLS AND TACKLES

The Contractor shall provide and install all necessary hoists, ladders, scaffolding, tools, tackles, all transport for labour and materials and plant necessary for the proper execution and completion of the work to the satisfaction of the Owner/PMC.

16. SAFETY OF MATERIALS:

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

17. CO-ORDINATION

Contractor shall fully Co-ordinate & render all necessary support and assistance to other contractors for completion of all MEP & Civil/Interior works to satisfaction & safety. This work will involve close Co-ordination with HVAC, BMS, Plumbing & Fire Fighting contractor including Civil contractor. Electrical contractor to ensure necessary safety linkages with AHU fire dampers & fire detection systems. Electrical contractor shall be fully responsible & accountable for these life safety linkages. Nothing extra can be claimed for this co-ordination support.

18. COMPLETION & AS BUILT DRAWINGS & DOCUMENTS:

On the completion of the work and before issuance of certificate of virtual completion, the contractor shall submit to the Architect/ Project Manager/ Owners/ Consultant five sets of **"AS BUILT DRAWINGS & DOCUMENTS"** drawn at approved scale.

- Contractor to submit a complete write-up of the electrical and LV system installed along with interlocking and safety schemes.
- All the shop drawings & final working drawings need to be converted into "AS BUILT" drawings based on actual executed conditions.
- Technical documents will also have the test certificates, test reports **& IR results** for all the electrical equipment/ material used in the installation, which will need to be submitted in proper folders. All the final DB charts shall also be included in the completion documents.
- Technical catalogues, operation & maintenance manuals of the all the products & equipment used in installation also to be submitted in proper folders. List of recommended spares is also to be furnished along with schedule of preventive maintenance is to be submitted as part of completion documents.
- All the "AS BUILT" drawings, test reports, test certificates & DB Charts must be signed and stamped by the contractors Engineer-in -Charge and the supervisor, who was responsible for the execution, testing & commissioning of the installation.
- Contractor shall be responsible for the correctness of the **"AS BUILT DRAWINGS & DOCUMENTS"** and shall sign & stamp them.

19. GUARANTEE:

At the close of the work and before issue of final certificate of virtual completion, the contractor shall furnish written guarantee indemnifying the owners against defective materials and workmanship for a period of one year after testing & commissioning of the installation. 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 damaged or destroyed as a result of defective workmanship by the contractor.

20. PERFORMANCE GUARANTEE

The contractor shall carry out the work in accordance with the Drawings, Specifications and other documents forming part of the contract.

The contractor shall be fully responsible for the performance of the selected equipment (installed by him) at the specified parameters and for the efficiency of the installation to deliver the required end result.

The contractor shall guarantee that the electrical system as installed shall perform to complete satisfaction of Owner's.

The contractor shall also guarantee that the performance of various equipment individually, shall not be less than the quoted capacity also actual power consumption shall not exceed the quoted rating, during testing and commissioning, handing over and guarantee period.

21. CONTACTOR'S ENGINEER-IN-CHARGE & OTHER STAFF:

- The contractor shall employ competent, fully qualified, trained & experienced full time electrical engineer/ Engineer-In-Charge/ Site Engineer/ Project Engineer to direct the work of electrical installation in accordance with drawings and specifications. The engineer shall be available at all times on the site to receive instructions from the consultant / Owner / Architect/ Project Manager / Owner in the day-to-day activities throughout the duration of the contract. The Engineer shall correlate the progress of the work in conjunction with all relevant requirements of the supply authorities.

- The Contractor shall employ only qualified, trained, experienced and licensed Project Engineer, Supervisor, foremen, wiremen and electricians.

- At the start of project, contractor shall furnish a list of employees i.e. Project Engineer, Supervisor, Foremen, Wiremen, and Electricians to be posted on the site, clearly specifying their qualification, experience and along with copies of qualification and trade certificates and licenses to establish / prove the furnished data.

- These details / certificates / copies of licenses of employees to be posted at site must be submitted to Project Manager / Architect/ Owner.

22. CONTRACTOR'S LICENCE:

Contractor shall be in possession of a valid Electrical contractor's license (to be issued by state's chief electrical inspectorate) for carrying out electrical works of the nature specified in the schedule of quantities and scope of works.

Contactor must furnish / submit a copy of the license to Project Manager/ Architect / Owner before start of the work.

23. TESTS & TEST REPORTS

On completion of complete installation, contractor shall submit to PMC/ Owner a signed copy of test report of complete installation and assume full responsibility of its soundness and safety.

Contractor shall physically inspect every material before installation and shall also carryout all necessary electrical tests such as:

a. IR values of Panels, DB's, Boards, cabling, sub mains, circuit and point wiring.
b. Checking and recording earth continuity, earth values of earthing pits and earthing conductor and entire earthing system and lightning arrestor system. Contractor shall be responsible for the adequacy of the earthing and lightning arrestor system and shall consider the changes in the BOQ as may be required but with the approval of the owners / PMC / site in-charge before execution.
c. Testing of all the relays and testing of transformers, HT switchgear and DG set alternator.
d. Checking all the terminations at panels, DB's and at lighting fixtures and socket outlets for tightness.

e. It is to be ensured by the contractor and its staff that all wire connections / cable connections / lighting and socket connections are with proper sized lugs / thimbles.

f. Contractor and its staff must follow good engineering practices.
g. A complete log of all the tests shall be maintained for review of Project Manager / Owner / Consultant.

h. Contractor shall assume full responsibility of correctness and validation of all the tests.

i. Any equipments / wire / cabling found faulty during testing carried out by contractor will be removed / replaced by healthy system / equipment by the contractor at its own cost.

v. Contractor shall assume full responsibility of safety of installation and shall be liable to owners for any loss / damage due to faulty equipment selection/ undersized equipment/ wrong design/ faulty installation / poor work-man-ship / poor quality.

k. It is contractor's responsibility to cross-check all the design and drawings before execution and assumes full responsibility for the correctness and adequacy of all the designs and drawings and shall be responsible and accountable to Owner for any deficiency and shortcomings in the system design/ product design.

24. COMPLETION CERTIFICATE:

On completion of the electrical installation a certificates shall be furnished by the contractor countersigned by Contractor's licensed supervisor, under whose direct supervision the installation was carried out. This certificate shall be in a prescribed form as required by the local electrical inspectorate / National Building Code. The contractor shall be responsible for getting the electrical installation inspected and approved by the local authorities concerned.

LIST OF INDIAN STANDARDS (BIS)

IS: 374 – 1979	Ceiling fans and regulators (3rd revision)
IS: 694 – 1990	PVC insulated Electric cable for working voltage upto and including 1100 volts.
IS: 732 – 1989	Code of practice for electrical wiring and installation
IS: 1255 – 1983	Code of Practice for installation and maintenance of Power Cables upto and including 33 KV rating (Second Revision)
IS: 1258 – 1987	Bayonet lamp holders (Third revision)
IS: 1293 – 1988	Three pin plugs and sockets outlets rated voltage upto and including 250 volts and rated current upto and including 160 amps.
IS: 1554 - 1988 (Part - I)	PVC insulated (Heavy Duty) electric cables for working voltages upto and including 1100 volts.
IS: 1646 – 1982	Electrical installation fire safety of buildings (general) Code of practice.
IS: 1885 – 1971	Glossary of items for electrical cables and conductors.
IS: 1913 - 1978	General and safety requirements for fluorescent lamps luminaries Tubular.
IS: 2026 - 1977 to 81 (Part I to IV)	Power Transformers
IS: 2071 - 1974 – 76	Methods of high voltage testing
IS: 2309 – 1989	Protection of building and allied structures against lightning
IS: 2551-1982	Danger notice plate
IS: 3043 – 1987	Code of practice for earthing.
IS: 3480 – 1966	Flexible steel conduits for electrical wiring.
IS: 3837 – 1976	Accessories for rigid steel conduit for electrical wiring.
IS: 4146 - 1983	Application guide for voltage transformers
IS: 4615 – 1968	Switch socket outlets.
IS: 5133 - 1969 (Part -I)	Boxes for the enclosure of electrical accessories.
IS: 5216 - 1982 (Part-I)	Guide for safety procedures and practices in electrical work.
IS: 5424 – 1969	Rubber mats for electrical purposes.

IS: 5578 & 11353-1985	Marking and arrangement of bus bars
IS: 7098 – 1985 (Part - II)	Cross linked polyethylene insulated PVC sheathed cables. For working voltages from 3.3 KV upto and including 33 KV
IS: 8130 – 1984	Conductors for insulated electric cables and flexible cords
IS: 8623 -1977 (Part -I)	Factory built assemblies of switchgear and control gear for voltages upto and including 1000 V AC and 1200 V D C.
IS: 8623 – 1980 (Part -II)	Bus Bar trunking system
IS: 8828 – 1996	Miniature Circuit Breakers
IS: 9537 – 1981	Rigid Steel Conduits for electrical wiring (Second Revisions)
IS: 10810 – 1988	Methods of test for cables.
IS: 12640 – 1988	Earth Leakage Circuit Breakers
IS: 13947-1993 (Part-II)	Air Circuit Breakers
IS: 13947-1989	Moulded Case Circuit Breakers
IS: 13947 – 1993	Degree of protection provided by enclosures for LV switchgear and control gear.
IS: 13947 – 1993	General requirement for switchgear and control gear for voltage not exceeding 1000 Volts.
IS: 1651 & 1652 1991	Stationary cells and batteries lead acid type.
IS: 13779	Digital measuring instrument and testing accessories.
IS: 7098 (Part 1)	XLPE Insulated HR PVC Sheathed Aluminum Conductor Armoured./ UnArmoured Cable.
IS: 3854 - 1997	**Switch Modules**
IS: 1293 - 1998	**Socket Modules**

Note:- 1. Follow relevant (amended upto date) Indian Standards in case the listed above are found not to be latest/upto date.

2. If codes of any/some of items are not written above, it is essential that relevant BIS Codes for these items are to be referred to

GUARANTEE PROFORMA

GUARANTEE FOR ELECTRICAL INSTALLATION

We hereby guarantee the year round Electrical System which we have installed in the Complex described below :

Building –

Location –

For a period of ONE YEAR from the date of acceptance of the total installation, WE AGREE TO repair or replace to the satisfaction of the Owner's, any or all such work that may prove defective in workmanship, equipment or materials within that period, ordinary wear and tear and unusual abuse or neglect excluded, together with any other work, which may be damaged or displaced in so doing. In the event of our failure to comply with the above mentioned conditions within a reasonable time, after being notified in writing, we collectively and separately, do hereby authorize the Owner's to proceed to have the defects repaired and made good at our expense, and we shall pay the cost and charges thereof, immediately upon demand.

WE ALSO HEREBY UNDERTAKE to test the entire installation upon completion and ensure that all systems are functioning satisfactorily.

SIGNATURE OF TENDERER
For ELECTRICAL INSTALLATION

DATE : SEAL

SUBHEAD-A **TRANSFORMER - OIL TYPE**

1. Scope

Design, manufacture, testing, supply, Installation, testing and commissioning of outdoor type 33 KV /11 KV transformers with ONAN cooling complete with all the accessories and fittings for efficient and trouble free operation. First filling of oil shall be at site by contractor.

2. Standards:

The equipment and accessories covered by this specification shall be designed, manufactured and tested in compliance with the latest relevant standards published by the Indian Standards institution wherever available in order that specific aspects under Indian conditions are taken care of.

The equipment and accessories for which Indian Standards are not available shall be designed, manufactured and tested in accordance with the latest standards published by any other recognized national standards institution.

The equipment shall also conform to the latest Indian Electricity Rules as regards safety, earthing and other essential provisions specified therein for installation and operation of electrical plants.

3. General Design And Constructional Features:

All materials used shall be of best quality and of the class most suitable for working under the site conditions and shall withstand the variations of temperature and atmospheric conditions, overloads, over-excitation, short circuits as per applicable standards, without distortion or deterioration or the setting up of undue stresses in any part, and also without affecting the strength and suitability of the various parts for the work which they have to perform.

The design shall be such that the risks of accidental short-circuit due to birds or vermin's are obviated. All apparatus, including bushing insulators and fittings shall be so designed that water cannot collect at any point. Marshaling kiosks, boxes etc. shall be adequately ventilated to prevent condensation of moisture and so treated internally as to prevent growth of fungi on any coils, wires and insulating materials used.

The transformers shall operate with minimum noise and vibration as per **NEMA** TR-1. The cores, tank and other structural parts shall be properly constructed so that the mechanical vibrations are kept to the minimum, thus reducing the noise.

The design of the transformer shall be such that changes in transformer connection can be made by a simple change of link connection inside the tank. The transformers shall be designed to suppress harmonic voltages, specially the third and fifth, so as to eliminate distortion in wave form, and the possibility of circulating currents between the neutrals at different transformer stations.

All transformers shall be of the latest design, oil filled as called for in the main specification. All transformers shall be suitable for outdoor installation. The type of cooling and the corresponding

ratings for each transformer shall be as indicated in the BOQ.

The magnetic circuit of each transformer shall be so designed as to minimize eddy- current and hysteresis losses in the core.

All electrical connections and contacts shall be of ample section for carrying the rated current without excessive heating.

4. Tank:

The transformer tank shall be made of steel plate, shaped in such a way that minimum of welding is required. The tank shall be electrically welded and all welding stresses shall be properly relieved. Tank walls shall be reinforced by adequate stiffeners to ensure mechanical rigidity permitting hoisting of complete transformers filled with oil and also to damp transformer noise. The tank shall be sufficiently strong to withstand shocks likely to be encountered during transport of the transformer without any deformation or weakening of joints. The joints shall be oil tight. Guides shall be welded on the inner side of the tank to facilitate tanking and untanking of the transformer core and coil assembly.

Tank cover shall be bolted on to the flanged rim of the tank with a suitable weather-proof, hot-oil-resistant gasket in between for oil tightness. The bolted tank cover shall be so arranged that it can be removed and the core inspected without removal of the radiators. All requisite access and inspection holes shall be provided with bolted oil tight, gasket seated cover plates. Bushing turrets, covers of access holes, covers of pockets to prevent leakage of water into the tank shall be provided.

The exterior of tank and other steel surface exposed to the weather shall be thoroughly cleaned and have a priming coat of zinc chromate applied. The second coat shall be of an oil and weather resistant nature preferably of distinct colour from the prime and finish coats. The final coat shall be of a glossy, oil and weather resisting non-fading paint of specified shade. The interior of the tank shall be cleaned by shot blasting and painted with two coats of heat resistant and oil insoluble paint.

Steel bolts and nuts exposed to atmosphere shall be galvanized however; surfaces of the transformer or other parts of the transformer or auxiliary equipment which are in contact with oil shall not be galvanized.

The transformer tank, auxiliary equipment and fittings shall be provided with necessary devices for lifting and haulage facilities. The tank shall be mounted on a substantial under-carriage.

Unless otherwise stated the tank together with radiators, conservator, bushings and other fittings shall be designed to withstand without permanent distortion the following conditions.

a) Full vacuum of 760mm of Hg for filling oil by vacuum.
b) Internal gas pressure of 0.35 Kg/Sq.cm. with oil at operating level.
c) Valves shall not leak nor any welded joints sweat under above conditions.

Adequate space shall be provided at the bottom of the tank for collection of sediments.

5. Core:

The magnetic circuit shall be built of transformer prime grade cold rolled grain oriented low loss steel stampings having high permeability and conforming to adopted standards. Stampings shall be insulated from each other with material having high inter-lamination insulation resistance and rust inhibiting property and also capable of withstanding pressure, mechanical vibration and action of heat and oil, thus reducing the possibility of sludge formation to a minimum.

The framework, clamping arrangement and general structure of the cores of each transformer shall be of robust construction and shall be capable of withstanding any shock to which they may be subjected during transport, installation and service. The assembled core shall be securely clamped, on the limbs and the yoke, to build up a rigid structure. The clamping pressure shall be uniform over the whole of the core and so adjusted as to minimize noise and vibration in the core when the transformer is in service. The framework and the core bolts shall be efficiently insulated from the core so as to reduce the circulating currents to a minimum.

The core clamping frame shall be provided with lifting eyes for the purpose of tanking and untanking the core with winding mounted thereon and shall have ample strength to take the full weight of the core and winding assembly.

An approved type of core grounding system shall be used; the grounding connections being located at the top of the core for easy access from the inspection hole. Transformer shall be of BOLTLESS core design to utilize maximum flux

6. Winding:

The coils used for transformer winding shall be flat in shape, made of paper insulated, continuous and smooth, tinned or enameled electrolytic copper conductors of high conductivity.

The transformer winding shall be designed for basic impulse insulation level not lower than that specified in **IS**.

Liberal ducts shall be provided to prevent any hot spot temperature in the winding that may adversely affect the life of the transformer. Adequate supports, wedges and spacers of hard insulating material shall be so fitted that they will neither move nor permit relative movement of any part of winding during transit of normal service or under terminal short circuit, nor damage the winding insulation in any way. All leads and connections shall be robust, adequately insulated, protected and clamped. The winding assembly shall be dried in vacuum with tested insulating oil of approved standard. The windings shall be subjected to a thorough shrinking and seasoning process so that no further shrinkage of windings occur during service at site. The assembly shall be held in position under adequate axial compression to withstand the axial thrust likely to occur under terminal short circuit.

The end turns on the high voltage winding shall have reinforced insulation to take care of the voltage surges likely to occur during switching or any other abnormal system condition.

The transformers shall be suitable for operation at full rated power on all tappings without exceeding the specified temperature rise as indicated in the applicable standards.

7. Insulating Materials:

The insulating oil shall conform to IS-335 and shall be suitable in all respects for operating the

transformer at the rating and under conditions specified in the main equipment specification. Sufficient oil shall be supplied for the first filling of transformer, the oil circulating equipment and the tank containing tap-changing mechanism and an extra 10% shall be supplied in non-returnable drums. The tender shall contain information about the grades of oil recommended by the transformer manufacturer for use in the transformer. Test certificates for the oil shall be furnished before dispatch of transformer and acceptance by owner.

8. Transformer Tappings:

33/11 KV, delta / star wound, Transformers shall be with on load tap changer.

Transformer shall be provided with 'ON' load tap changing on 33 KV side. The tapings to be provided for variation on HV side from +5% to – 10% in steps of 1.25% each. Provision of bushing shall be made for neutral and neutral CTs shall also be provided.

OLTC shall be automatic, motor operated, resistive transition impedance type suitable bidirectional power flow. Diverter switch contacts in separate housing not communicating with main tank. OLTC chamber with drain plug, oil filling plug, relief vent, oil level gauge, oil surge relay, breather & separate conservator shall be provided.

OLTC shall be provided with operation counter, tap position indicator, out of step relay, pressure relief valve and any other necessary accessories.

A) Following items shall be provided for OLTC (To be shifted to Oil type trafo and suitably modified with the data already available there)

- High Torque Electric motor suitable for 415 Voltas, 3 phase, 50 Hz AC supply.
- Motor drive and energy accumulator
- Motor isolating device with over load protection
- Contactors for forward and reverse operation of motor-'Raise/Lower' control for local & remote operation.
- 'Raise/Lower' Limit switch.
- Interlock between manual & electrical operation.
- Auxiliary transformer.
- Retainer Switch
- Tap Position Indicator
- Tap operation counter
- Stoppers to prevent over travelling of mechanism
- Internal illuminating lamp with switch.
- 'Local/Remote' control selector switch.
- Auto/Manual selector switch.
- Anti-condensation heater with switch and thermostat
- Handle for manual operation.
- Driving Mechanism chamber locking arrangement.
- Terminal Strips
- Lubricating Chart
- Undrilled gland plate for cable entry.

B) The following shall be required for remote indicating. :

- Potentio meter for remote tap position indicator
- Contacts for Tap change in progress indication.
- Contacts for Upper and Lower limit reached indication.

- Contacts for Tap change stuck / incomplete indication.

9. Cooling Equipment:

Natural cooling by means of banks of detachable type radiators made from pressed/round tubes around transformer tank shall be provided. The radiators shall be of seamless mild steel sheet with clean bright internal surface and shall be suitably braced to protect them from shock.

It is recommended to provide sprinklers at 6.3 MVA transformers at Main receiving station.

10. Terminal Arrangement

10.1 High Voltage Side (33 KV or 11kV)

Cable box shall be provided suitable for terminating one no. 3C x 240 sq.mm XLPE insulated armoured 33 KV cable complete with disconnecting chamber, compression glands, tinned copper lugs, Armour earth clamp and body earth terminal.

Cable box shall be fitted with bushing insulators for H.T. cable termination side.

10.2 Low Voltage Side (11 KV or 433V)

12 & 2 MVA, 33 KV / 11 KV delta / star Transformers – 11 KV Cable, outdoor connections shall be made.

10.3 Disconnecting Chamber

The disconnecting chamber shall be air insulated and complete with seal off bushing, removable flexible connectors / links and removable covers. It shall be possible to trail out the transformer without having disconnecting the bus duct / cables.

Phase to phase and phase to ground clearances within the chamber shall be such as to enable either the transformer or cable to be subjected separately to H.V. test.

10.4 Bushing:

Bushings shall confirm to IS: 2099 and other relevant standards.
Bushings shall be supplied with terminal connector clamp suitable for connecting the bushing terminal to the owner's conductor.
Creepage distance of bushing shall be (41mm/kv phase ground) adequately,

11. Marshalling Box

Whenever optional fittings, temperature indicators, with auxiliary contacts, Buchholtz Relay and Bushing CT's are specified then the bidder shall provide a Marshalling box and Marshall to it all the contact terminals of electrical devices mounted on the transformer. It shall be in the contractor's scope to provide:

a) The interconnection cabling between the Marshalling box and the accessory devices either by PVC insulated copper wire in G.I. conduits or PVC insulated copper conductor armoured cables.

b) Necessary double compression type brass cable glands at the Marshalling box for above cables.

The Marshalling box shall be tank mounted, water/dust tight sheet steel (2mm thick) enclosed with hinged door having padlocking facility. All doors, covers and plates shall be fitted with neoprene gaskets. Top surface shall be sloped and bottom shall be atleast 600mm from floor and provided with gland plate and cable glands as required. Glass window for viewing indicators. Shall be IP 55

Terminals shall be clipon type rated for 10A. All contacts for alarm/trip indication shall be potential free, wired up to the terminal block. Wiring shall be done with stranded copper conductor wires of sizes not less than 1.5 sq.mm for control and 2.5 sq.mm for CT circuits. C.T. terminals shall be provided with shorting facility.

12. Electrical & Performance Requirement:

Transformer shall operate without injurious heating at the rated KVA at any voltage within +/- 10% of the rated voltage of that particular tap.

Transformer shall be designed for 110% continuous over fluxing withstand capability corresponding to rated voltage.

The neutral terminals of the winding with star connection shall be designed for the highest over current that can flow through the winding.

Overloads shall be allowed within the conditions defined in the loading guide of the applicable standard. Under these conditions, no limitations by terminal bushings, tap changers or other auxiliary equipment shall apply.

Temperature Rise shall be continuously rated for full load. The temperature rise shall not exceed 45 degree C by thermometer in oil or 55 degree centigrade in winding by resistance over an ambient of 32 degree C.

13. Earthing:

13.1 Two separate earthing terminals to be provided at the bottom of the tank on opposite sides. The terminals shall be suitable for connection to grounding strip.

13.2 Internal Earthing:

The frame work and clamping arrangements of core and oil shall be securely earthed inside the tank by adequately sized copper strip connections to the tank.

14. Fittings And Accessories:

The transformer shall be provided with all standard fittings and accessories specified in the applicable standard for the size and type of transformer concerned. The accessories and fittings shall generally be as specified below:

- Lifting Lugs:

The arrangement for lifting the active part out of the transformer tank along with the cover by means

of lifting lugs without disturbing the connections.

- Swivel Type Rollers:
  The transformer to be provided with 4 No's Bi-Directional rollers fitted on cross channels to facilitate the movement of the transformer in both directions.

- Oil Conservator:
  The transformer to be provided with an oil conservator with welded end plates. It is to be bolted to the cover and can be dismounted for purpose of transport. It has to be provided with magnetic oil level gauge and an oil filling hole 1 1/4" BSF size with a cap, which can be used for filtering oil. For draining purpose a plug shall provided. A connection pipe between the conservator and the main tank is to be provided which projects inside the conservator and the main tank is to be provided which projects inside the conservator.

- Air release Valve:
  An air release valve is to be provided on the top of the tank cover facilitate the release of the entrapped air and filling of oil.

- Breather:
  The transformer to be provided with an indicating dehydrating silica gel breather of sufficient capacity.

- Drain-cum-oil Filter Valves:
  The transformer to be provided with a drain-cum-oil filter valve of 1 1/4" BSF size at the bottom of the tank.

- Diagram and rating plate:
  Diagram and rating plate shall be provided indicating the details of transformer, connection diagram, vector group, tap changing diagram etc.

- Dial type Magnetic thermometer (150 mm dia) with maximum set pointer at 75 deg C and electrical contacts for electrical alarm at high temperature. Provision for remote display on the RTCC and 4-20mA signal for SCADA input)

- Dial type Winding temperature indication and electrical contacts for trip / alarm Provision for remote display on the RTCC and 4-20mA signal for SCADA input)

- Buchholz relay of double float type with electrical contacts for low oil level alarm and high gas pressure trip suitable for 24 volts DC supply.

- Filter valve of 1 1/4" BSF at top.

- Explosion vent.

- Repeater for Oil and Winding Alarm and Trip for BMS connection.

- RTD for temperature signal to BMS.

- Surge Relay

Include following fittings and Accessories to be considered :-

a. Valve diagram plate.
b. ON load tap changer with accessories
c. Drain off valve at lowest location to allow complete draining
d. Oil sampling device at top and bottom
e. Pockets with thermometers for oil temperature and winding temperature indicators
f. Bar type level gauge with alarm contacts
g. HV, LV and neutral bushings.
h. Bushing CTs as specified
i. Lifting lugs and jacking pads
j. Inspection covers
k. Cable/ busduct disconnecting chamber

15. Drawings And O&M Manuals:

Four copies of manual of complete instructions for the installation, operation, maintenance and repairs circuit diagrams, foundation and trenching details shall be provided with the transformers. List of spare parts shall also be indicated.

Two copies of the drawings incorporating the following particulars shall be submitted with the offer for preliminary study.

GA drawing showing dimension, net weight and shipping weight, quantity of insulating oil etc.

Suitable capacity of crane requirements for assembly and dismantling of the transformer.

Drawing indicating GA of busduct/cable box and its dimension for cable entry cut out requirements etc.

The drawings in (four sets) to be furnished by the supplier for approval after acceptance of his order shall include the following.

GA showing front and side elevations and plan of transformer and all accessories and external features, detailed dimensions, crane lift for untanking, oil quantity, H.T./L.T. clearances etc.

Drawings of Bus duct/cables termination arrangement.

HV cable box arrangement & disconnecting chamber GA & details drawings.

Drawing of each type of bushing.

Name plate and terminal making and connection diagram.

Control wiring & schematic diagram showing polarity and vector group of windings, CTs and OTI, WTI, circuits, Alarm/trip circuits etc.

Reproducible copy of the above drawings for records

Maximum allowable Power losses shall be as per ECBC norms.

Testing:

The transformer shall be subjected to all routine tests in accordance with IS : 2026 at the factory before dispatching the same and test certificates shall be furnished.

Testing at site:

a) Insulation test of HT and LT winding
b) Oil dielectric strength test
c) Ratio test of transformer

Four copies of the test reports in bound volume shall be submitted for approval.

SOAK PIT AND DRAIN PIT (Wherever required) shall be provided as per IS 10028- 2.

The transformers foundation shall be surrounded by a suitable soak pit enclosed by a 150 mm high non- combustible curb. This soak pit shall be filled with coarse crushed stones about 25mm in diameter to a minimum depth of 300 mm. The volume of the soak pit minus the volume of the stones should be sufficient to contain the entire oil content of the transformer if the oil content is less than or equal to 5 kl. In case the oil content is more than 5 kl, the volume of soak pit minus the volume of stones should be sufficient to contain at least one third of the total oil content. The excess should be led through two or more hume /concrete pipes (min. 150 dia.) from bottom of pit to a central remote burnt oil tank.

16. Remote Tap Changer Control Panel (RTCC) for 33/11kV, 12MVA transformer

RTCC panel shall be of sheet steel cabinet for indoor installation, floor mounting type. The RTCC panel shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket and padlocking arrangement. RTCC panel shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of RTCC panel shall be 14 SWG CRCA sheet steel and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to IS-8623-1977 (part-I) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of RTCC panel. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panel.

The following components shall be provided in the RTCC panel:

a) Digital Tap Position Indicating Meter
b) Raise/Lower Push Buttons for Remote Control of OLTC
c) Tap Change in Progress Signal Lamp.
d) Supply on Signal Lamp
e) Local / Remote Control Indicating Lamps
f) Panel illuminating lamp with door switch.
g) Space Heater with Switch and Thermostat.
h) Automatic Voltage Relay with Time Delay Element.
i) Selectors switch for Auto/Manual Operation.
j) Undrilled Gland Plate for Cable entry.
k) Earthing Terminal
l) Lifting Eyes Bolts.

Add the following data sheet

Particulars	**12 MVA, 33/11kV**
Specification	IS 2026, Part I - 1977 Part II - 1977 Part III – 1981 Part IV - 1977 IEC -60076 – 2000/2002
Type	Three phase, core type, oil filled
Duty	Outdoor, installed in open yard / trafo pen.
Voltage HV/LV kV	33/11
Frequency	50 Hz
No. of phase	3
Continuous rating	12MVA
Insulation class	Class A
Cooling	ONAN
Winding connection	Star/ Delta
Vector group	Dyn11
System earthing	33kV- Effectively earthed 11kV – Resistance earthed
Percentage impedance	7.5 % @ 6.3 MVA
Impedance tolerance	+5 %, -10%
Termination	33kV – AL cable 11kV – AL cable
Temperature rise over 50°C ambient temp	
a) In oil (measured by Thermometer)	45 deg. C
b) In winding (measured by Resistance method)	55 deg. C
Bushing mounted CT's	
a) HV bushing mounted PS class CT for differential protection	
b) HV Neutral bushing PS Class CT for REF protection.	-

Particulars	12 MVA, 33/11kV
c) HV Neutral bushing CT for standby E/F protection class 5P20	-
d) LV bushing mounted PS class CT for differential protection	
e) LV Neutral bushing PS class CT for REF protection.	1 Set (400/1A)
f) LV Neutral bushing CT for strand by E/F protection 5P20	1 Set (200/1A)
Tap changer on primary side	On load high speed resistor transition
a) Range	+5%, to -15%
b) Total tap positions	17
c) Taps above nominal voltage	8
d) Taps below nominal voltage	8
e) Voltage per step variation	+/-1.25%
f) Tap change controls	Local Manual, local electrical, remote electrical, fully automatic
Impulse test withstand voltage kVp	170/75
One minute dry and wet power frequency withstand voltage kV rms	70/28
Induced over voltage withstand voltage	As per IS 2026, Part III – 1981
Short circuit level on HV side	750 MVA
Short circuit level on LV side	450 MVA
Withstand time without injury for 3 phase short circuit at secondary terminals	2 Seconds.
Auxiliary supply voltage	220 V DC/ 415 V AC
Parallel operation	Suitable for parallel operation with transformers of similar ratings
Overload capacity	As per IS 6600 –1972
Radiators	Detachable type
Flux density (at rated voltage)	1.6 Tesla Max
Magnatizing current	1.0% of rated current
Current density	2.5A / sqmm
Maximum Losses	No Load Loss : 5.5 kW Load Loss : 43 kW

SUB-HEAD: B1. **HT VCB SWITCH BOARD – 33KV VCB OR 22 KV VCB**

1. General

Manufacturing, testing, supplying and commissioning of integrated cubicle type, floor mounted, free standing extensible sheet steel enclosed, front operated indoor type 33 kV or 22 KV switch board as per specifications given below:

System: The switch board shall be suitable for the following system.

a.	Rated voltage	-	33 kV or 22 kV, 3phase (earthed system)
b.	Rated frequency	-	50 cycles
c.	Fault level withstand	-	1000 MVA at 33 KV for 3 sec or as specified in the Schedule of Quantities & 750 MVA at 22 KV for 3 sec or as specified in the schedule of quantities.
d.	VCB life	-	Min. 10,000 operations ON/OFF electrical / vendor to specify in offer if not 10,000 operations.

2. Site conditions climatic conditions

Ambient temperature & RH	-	50^{o}C maximum for outdoor installation & 45°C for indoor installation & Relative Humidity 90% RH.
	-	0°C minimum

The switchgear should be suitable to operate without any capacity deration at the climatic condition listed above and at the altitude of the site of installation.

3. Standard

Unless otherwise stated below HT switchboard shall conform to relevant Indian standards.

4. Construction features

The switchboard shall be made from CRCA sheet steel 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding slag grounded off and welding pits wiped smooth with plumber metal. Panels shall be totally enclosed design, completely dust tight and vermin proof **with IP-44 for totally indoor application & IP-55 for outdoor application completely dust, vermin and water-proof,** protection grade. Gaskets between all adjacent units and beneath all cover shall be used to render the joints effectively dust tight. Panel shall be draw out type. Panel shall be provided with filter fans and exhaust filters as required for ventilation purpose. The unit shall be equipped with heater and thermostat.

Application	IP Rating
Indoor Application in substation areas	**IP-44**
Outdoor Application	IP 55

Outdoor ones will have a canopy and a double door.

NOTE: These IP ratings need to be adhered to strictly even if it is not mentioned or mentioned otherwise in the B.O.Q.

5. Instrument accommodations

Separate and adequate compartment shall be provided for accommodating instruments, indicating lamps, control contactors and control fuses etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, bus-bar and connections.

6. Circuit breaker

The panel shall be provided with TP 33 kV or 22 kV indoor type vacuum breaker as specified in the schedule of quantities with symmetrical breaking capacity of 1000 MVA at 33 kV for 3 sec or as specified in the schedule of quantities, and 750 MVA at 22 KV for 3 sec or as specified in the schedule of quantities

The breaker shall be flush front, metal clad, draw out type and shall be provided with trip free, manual/spring charged/motorized closing mechanism (as called for in the schedule of quantities) with mechanical ON / OFF indication. The operating handle and the mechanical trip push button shall be at the front of the breaker and integral with the breaker and provision shall be made for remote operation of breakers and local / remote changeover switch for ON/OFF to be pistol grip type stay put.

7. Circuit

Each circuit breaker shall be housed in separate compartment and shall be enclosed on all sides. The following safety interlocks shall be provided.

7.1 The breaker can't be plugged in unless it is off.
7.2 The breaker can't be drawn out when it is on.
7.3 Tank can be removed when the breaker is on.
7.4 The breaker can't be plugged in with the tank off.
7.5 Automatic shutters prevent the access to bus bar when breaker is removed.

8. Cradle

The cradle shall be so designed and constructed as to permit smooth withdrawal and intersection of the breaker. The movement shall be free of jerks, easy to operate and shall preferably be on steel balls/rollers and not on flat surfaces.

9. Service

Both mains and secondary isolating contacts in service.

9.1 Test

Main isolating contacts separated and secondary contacts in service.

9.2 Isolated

Both main and secondary isolating contacts isolated.

9.3 Maintenance

Circuit breaker fully outside the cubical

10. Barriers

Steel sheet barrier shall be provided between:-

10.1 Instrument panel and potential transformer.
10.2 Instrument panel and current transformer.
10.3 Bus-bar chamber and circuit breaker compartment

11 Bus bars and connections

11.1 The bus bar shall be of electrolytic tinned copper and rectangular cross section suitable for rated capacity with heat shrinkable colour coded sleeves. Bus bar's to be of copper completely surrounded with insulation suitable for 22kV / 750 MVA or 33 kV / 1000 MVA for 3 sec. or as specified in the BOQ.

11.1 The bus bar shall be rigidly fixed on insulated supports to with stand short circuit and mechanical stresses. All bus bar connection shall be fully enclosed so as to leave no exposed live parts and shall present a neat appearance. An earth bar of 50mm x 6mm copper size shall be provided with the switchboard.

12. Terminals

All the cable terminations shall be at the rear side of the panel in adequate length for connecting the cable. Side terminations may be considered. Bus bars to be completely surrounded with insulation suitable for 22kV / 750 MVA or 33 kV / 1000 MVA fault level or as specified in the BOQ.

13. Protective devices

13.1 Circuit breaker shall be provided with the triple pole IDMT relay for combined over current and earth fault protection, suitable for 24-volt operative power along with batteries and charger.
13.2 Auxiliary trip relays for winding temperature trip of & oil temp trip transformers to be provided in case of oil type transformer.
13.3 Master trip relay to be provided.
13.4 Surge suppressor 3 pcs one set of surge suppressor on cable side per VCB (As per BOQ).

14. Instrument transformer

14.1 The panel shall be provided with suitable but not less than 150 VA burden, accuracy class 1 potential transformers of ratio 33000/110 volts or 22000/110 volts (for 33kV & 22kV respectively) with HV and MV fuses. Potential transformer shall be draw out type.
14.2 Panel shall be provided with accuracy class 1.0 current transformer of required VA burden for metering and protection.
14.3 All control circuits shall be provided with proper and adequate protective fuse. All fuses shall be easily accessible from front only.
14.4 Instrument testing plug shall be provided for testing the meters.

15. Metering

Panel shall be provided with BMS / Non BMS Compatible multifunction meter with MDI in the incomer and Ammeter & Voltmeter with selector switches as called for in the BOQ:
15.1 Ammeter with selector switch as called for in the outgoings.

NOTE: For exact requirement of metering per breaker module, refer Schedule of Quantities.

16 Wiring

All wiring for meters and relays shall be copper conductor wires and shall be colour coded and labeled with approved plastic beads for identification. The size of the conductor should not be less than 2.5 sqmm. Copper wire.

17. Indicating lamps

LED type indicating lamps shall be provided for:

A. At Incomer:

17.1 Phase indication (R, Y, B).
17.2 Breaker "OFF" breaker "ON" and breaker ''TRIP'' conditions (Red, Green, Amber).
17.3 Trip Circuit healthy (Green).
17.4 Spring Charged (Blue).
17.5 DC Control Supply healthy.
17.6 VCB in Service.

B. At Outgoing:

17.7 Breaker "OFF" breaker "ON" and breaker ''TRIP'' conditions (Red, Green, Amber).
17.8 Trip Circuit healthy (Green).
17.9 Spring Charged (Blue).
17.10 DC Control Supply healthy.
17.11 VCB in Service.

18 Earthing

Main copper earth bar of 50 mm x 6 mm shall be provided and connected to the framework of the switchboard. Provision shall be made for connections from the earth bar to the substation earth on both sides of the switchboard.

19. Painting

All sheet steel work shall be undergo a process of degreasing, pickling in acid, cold rinsing and then sprayed with a high corrosion resistant primer. The primer shall be baked in an oven. The finishing treatment shall be by application of synthetic enamel paint of approved shade and stored.

20. Mechanical operation counter to be provided.

21. Breaker operated auxiliary switches – 6 NO. & 6 NC to be provided.

22. 6/8/12 window annunciation panel to be provided as called for in the BOQ.

23. Labels

The breaker shall have Formica circuit labels in black and white indicating where they serve.

24. Drawings

Two sets of detailed technical literature and dimensional drawings shall be submitted with the tender and 3 copies of the manual of complete instruction for the installation, operation, maintenance and repairs, circuit diagrams, foundation and trenching details shall be provided with the switch board.

25. Testing & Commissioning:

HV switch shall be subject to tests specified in relevant Indian standards before dispatching and tests certificates shall be furnished.

Prior to commissioning of HV switchboard following tests shall be carried out at site:

Mechanical endurance test shall be carried out by closing and opening of the circuit breaker. Insulation resistance test shall be carried out between phase and phase to earth with 5kV megger.

All control relays and tripping mechanism shall be checked for proper operation.

Secondary current injection of all protection relays.

26. DC Power Pack:

One Power pack shall be suitable for 2 panels.
It shall be "SMPS based DC Power pack, constant voltage, constant current type, self powered power pack protected from overcharging, short circuit & fuse at Input, input voltage 230V / 110V AC ± 20% and output voltage 24V DC with 7AH Sealed maintenance free (SMF) Battery.

27. Details of Relays & Meters (As Detailed out in the BOQ):

- Voltmeter with Selector Switch, Ammeter with Selector Switch & Digital Multifunction Meter with MDI at the incomer.
- Amp meter + ASS for all out going feeders
- Microprocessor based IDMT Relays, communication type with LED fault display.
- Transformer faults
- Lockout relay
- Anti pumping relay
- Trip circuit supervision relay
- Master trip relay
- Control switchgear
- Pistol grip breaker ON/OFF/ON Spring return
- Pistol grip local remote switch
- Indication lights
- Breaker ON, OFF, Fault trip
- Fault alarm
- Wiring, fuses as required
- Space heaters as required with switches and auto operation

Type	:	CVCC (constant voltage constant current)
Rated Input Voltage	:	230 VAC
Input Voltage Tolerance	:	170v to 270 V
Rated Input Frequency	:	50 Hz.
Input Frequency Tolerance	:	± 5%
Output Voltage(AC mode)	:	26.0 Volts
Output Voltage(DC mode)	:	24.0 Volts
Batterry	:	12V7AH X2
Output Current	:	0-10Amps.(for Tripping).
Tripping	:	8-10(Depending on Batt.Condition)
Ripple filtration	:	4,700mfd. /50V
Surge Suppression time	:	< 5pico seconds
Spike suppression energy	:	20 Joule
Short Circuit protection	:	Fuse
Recharge time	:	8-10hrs. /Condition
Protections	:	Over Charge and low battery Electronically controlled.
Indications	:	AC-ON,DC-ON,Ch.Fail
Ventilation	:	Air cooled
Mounting	:	Surface/Wall
Dimensions	:	

TECHNICAL DATA SHEET TO BE FILLED BY VENDOR

S. No	Description	To be Filled by Vendor
1	IP Rating	
2	Indoor/ Outdoor Type	
3	Operating Voltage	
4	No. of Panels	
5	Breaker - Type/ Operation	
6	Fault Withstand Rating	
7	Type of Busbars - Copper.	
8	Type of CT's for Metering & Protection • CT Ratio • VA burden • Accuracy Class • Ring or Bar type	
9	Type of PT's & Voltage Ratio	
10	Metering & Indications Details	
11	Details of Auxiliary Contacts & Annunciator Panel	
12	Type & Details of Relays	

Note: Provide Data Sheet for each panel i.e. Incoming & Outgoing.

SUB-HEAD: B2. **HT VCB SWITCH BOARD – 11 KV VCB**

1. General

Manufacturing, testing, supplying & commissioning of integrated cubicle type, floor mounted, free standing extensible sheet steel enclosed, front operated indoor type 11 kV switch board as per specifications given below:

System:- The switch board shall be suitable for the following system.

a.	Rated voltage	-	11 kV, 3phase (earthed system)
b.	Rated frequency	-	50 cycles
c.	Fault Level withstand	-	350 MVA at 11 KV for 3 sec or as specified in the B.O.Q.
d.	VCB life	-	Min. 10,000 operations ON/OFF electrical / vendor to specify in offer if not 10,000 operations.

2. Site conditions climatic conditions

Ambient temperature & RH	-	50^{o}C maximum for outdoor installation & 45°C for indoor installation & Relative Humidity 90% RH.
	-	0°C minimum

The switchgear should be suitable to operate without any capacity de-ration at the climatic condition listed above and at the altitude of the site of installation.

3. Standard

Unless otherwise stated below HT switchboard shall conform to relevant Indian standards.

4. Construction features

The switchboard shall be made from CRCA sheet steel 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding slag grounded off and welding pits wiped smooth with plumber metal. Panels shall be totally enclosed design, completely dust tight and vermin proof **with IP-44 for totally indoor application and IP-55 for outdoor application completely dust, vermin and water-proof,** protection grade. Gaskets between all adjacent units and beneath all cover shall be used to render the joints effectively dust & water tight. Panel shall be draw out type. Panel shall be provided with filter fans and exhaust filters as may be required for ventilation purpose. The unit shall be equipped with heater and thermostat.

Application	IP Rating
Indoor Application in substation areas	**IP-44**
Outdoor Application	IP 55

Outdoor ones will have a canopy and a double door.

NOTE: These IP ratings need to be adhered to strictly even if it is not mentioned or mentioned otherwise in the B.O.Q.

5. Instrument accommodations

Separate and adequate compartment shall be provided for accommodating instruments, indicating lamps, control contactors and control fuses etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, bus-bar and connections.

6. Circuit breaker

The panel shall be provided with TP 11 kV indoor type vacuum breaker as specified in the schedule of quantities with symmetrical breaking capacity of 350 MVA at 11 kV for 3 sec or as specified in the BOQ.

The breaker shall be flush front, metal clad, draw out type and shall be provided with trip free, manual/spring charged/motorized closing mechanism (as called for in the schedule of quantities) with mechanical ON / OFF indication. The operating handle and the mechanical trip push button shall be at the front of the breaker and integral with the breaker and provision shall be made for remote operation of breakers and local / remote changeover switch for ON/OFF to be pistol grip type stay put.

7. Circuit

Each circuit breaker shall be housed in separate compartment and shall be enclosed on all sides. The following safety interlocks shall be provided"

7.1 The breaker can't be plugged in unless it is off.
7.2 The breaker can't be drawn out when it is on.
7.3 Tank can be removed when the breaker is on.
7.4 The breaker can't be plugged in with the tank off.
7.5 Automatic shutters prevent the access to bus bar when breaker is removed.

8. Cradle

The cradle shall be so designed and constructed as to permit smooth withdrawal and intersection of the breaker. The movement shall be free of jerks, easy to operate and shall preferably be on steel balls/rollers and not on flat surfaces.

9. Service
Both mains and secondary isolating contacts in service.

9.1 Test
Main isolating contacts separated and secondary contacts in service.

9.2 Isolated
Both main and secondary isolating contacts isolated.

9.3 Maintenance
Circuit breaker fully outside the cubical

10 Barriers

Steel sheet barrier shall be provided between:-

10.1 Instrument panel and potential transformer.
10.2 Instrument panel and current transformer.
10.3 Bus-bar chamber and circuit breaker compartment

12 **Bus bars and connections**

12.1 The bus bar shall be of electrolytic tinned copper and rectangular cross section suitable for rated capacity with heat shrinkable colour coded sleeves. Bus bar's to be of copper completely surrounded with insulation suitable for 11kV and system fault level of 350MVA for 3 sec. or as specified in the BOQ.

12.2 The bus bar shall be rigidly fixed on insulated supports to with stand short circuit and mechanical stresses. All bus bar connection shall be fully enclosed so as to leave no exposed live parts and shall present a neat appearance. An earth bar of 50mm x 6mm copper size shall be provided with the switchboard.

13 Terminals

All the cable terminations shall be at the rear side of the panel in adequate length for connecting the cable. Side terminations may be considered. Bus bars to be completely surrounded with insulation suitable for 11kV / 350 MVA fault level or as specified in the BOQ.

14 Protective devices

14.1 Circuit breaker shall be provided with the triple pole IDMT relay for combined over current and earth fault protection, suitable for 24-volt operative power along with batteries and charger.

14.2 Auxiliary trip relays for winding temperature trip & oil temperature trip of transformer to be provided in case of oil type transformer.

14.3 Master trip relay to be provided.

14.4 Surge suppressor 3 pcs one set of surge suppressor on cable side per VCB (As per BOQ).

15 Instrument transformer

15.1 The panel shall be provided with suitable but not less than 150 VA burden, accuracy class 1 potential transformers of ratio 11000/110 volts with HV and MV fuses. Potential transformer shall be draw out type.

15.2 Panel shall be provided with accuracy class 1.0 current transformer of required VA burden for metering and protection.

15.3 All control circuits shall be provided with proper and adequate protective fuse. All fuses shall be easily accessible from front only.

15.4 Instrument testing plug shall be provided for testing the meters.

16. Metering

Panel shall be provided with BMS / Non BMS Compatible multifunction meter with MDI in the incomer and Ammeter & Voltmeter with selector switches as called for in the BOQ:

16.1 Ammeter with selector switch as called for in the outgoings.

NOTE: For exact requirement of metering per breaker module, refer Schedule of Quantities.

16 Wiring

All wiring for meters and relays shall be copper conductor wires and shall be colour coded and labeled with approved plastic beads for identification.

17 Indicating lamps

LED type indicating lamps shall be provided for:

A. At Incomer:

17.1 Phase indication (R, Y, B)

17.2 Breaker "OFF" breaker "ON" and breaker ''TRIP'' conditions (Red, Green, Amber).

17.3 Trip Circuit healthy (Green).

17.4 Spring Charged (Blue).

17.5 DC Control Supply healthy.

17.6 VCB in Service.

B. At Outgoing:

17.7 Breaker "OFF" breaker "ON" and breaker ''TRIP'' conditions (Red, Green, Amber).

17.8 Trip Circuit healthy (Green).

17.9 Spring Charged (Blue).

17.10 DC Control Supply healthy.

17.11 VCB in Service.

18 Earthing

Main copper earth bar of 50 mm x 6 mm shall be provided and connected to the framework of the switchboard. Provision shall be made for connections from the earth bar to the substation earth on both sides of the switchboard.

19 Painting

All sheet steel work shall be undergo a process of degreasing, pickling in acid, cold rinsing and then sprayed with a high corrosion resistant primer. The primer shall be baked in an oven. The finishing treatment shall be by application of synthetic enamel paint of approved shade and stored.

20. Mechanical operation counter to be provided.

21. Breaker operated auxiliary switches – 6 NO. & 6 NC to be provided.

22. 6/8/12 window annunciation panel to be provided as called for in the BOQ.

23. Labels

The breaker shall have Formica circuit labels in black and white indicating where they serve.

24. Drawings

Two sets of detailed technical literature and dimensional drawings shall be submitted with the tender and 3 copies of the manual of complete instruction for the installation, operation, maintenance and repairs, circuit diagrams, foundation and trenching details shall be provided with the switch board.

25. Testing & Commissioning:

HV switch shall be subject to tests specified in relevant Indian standards before dispatching and tests certificates shall be furnished.

Prior to commissioning of HV switchboard following tests shall be carried out at site:

Mechanical endurance test shall be carried out by closing and opening of the circuit breaker. Insulation resistance test shall be carried out between phase and phase to earth with 5kV megger.

All control relays and tripping mechanism shall be checked for proper operation.
Secondary current injection of all protection relays.

26. DC Power Pack:

One Power pack shall be suitable for 2 panels.
It shall be "SMPS based DC Power pack, constant voltage, constant current type, self powered power pack protected from overcharging, short circuit & fuse at Input, input voltage 230V / 110V AC ± 20% and output voltage 24V DC with 7AH Sealed maintenance free (SMF) Battery.

27. Details of Relays & Meters (As Detailed out in the BOQ):

- Voltmeter with Selector Switch, Ammeter with Selector Switch & Digital Multifunction Meter with MDI at the incomer.
- Amp meter + ASS for all out going feeders
- Microprocessor based IDMT Relays, communication type with LED fault display.
- Transformer faults
- Lockout relay
- Anti pumping relay
- Trip circuit supervision relay
- Master trip relay
- Control switchgear
- Pistol grip breaker ON/OFF/ON Spring return
- Pistol grip local remote switch
- Indication lights
- Breaker ON, OFF, Fault trip
- Fault alarm
- Wiring, fuses as required
- Space heaters as required with switches and auto operation

Type	:	CVCC (constant voltage constant current)
Rated Input Voltage	:	230 VAC
Input Voltage Tolerance	:	170v to 270 V
Rated Input Frequency	:	50 Hz.
Input Frequency Tolerance	:	± 5%
Output Voltage(AC mode)	:	26.0 Volts
Output Voltage(DC mode)	:	24.0 Volts
Batterry	:	12V7AH X2
Output Current	:	0-10Amps.(for Tripping).
Tripping	:	8-10(Depending on Batt.Condition)
Ripple filtration	:	4,700mfd. /50V
Surge Suppression time	:	< 5pico seconds
Spike suppression energy	:	20 Joule
Short Circuit protection	:	Fuse
Recharge time	:	8-10hrs. /Condition
Protections	:	Over Charge and low battery Electronically controlled.
Indications	:	AC-ON,DC-ON,Ch.Fail
Ventilation	:	Air cooled
Mounting	:	Surface/Wall
Dimensions	:	

TECHNICAL DATA SHEET TO BE FILLED BY VENDOR

S. No	Description	To be Filled by Vendor
1	IP Rating	
2	Indoor/ Outdoor Type	
3	Operating Voltage	
4	No. of Panels	
5	Breaker - Type/ Operation	
6	Fault Withstand Rating	
7	Type of Busbars - Copper.	
8	Type of CT's for Metering & Protection • CT Ratio • VA burden • Accuracy Class • Ring or Bar type	
9	Type of PT's & Voltage Ratio	
10	Metering & Indications Details	
11	Details of Auxiliary Contacts & Annunciator Panel	
12	Type & Details of Relays	

Note: Provide Data Sheet for each panel i.e. Incoming & Outgoing.

SUB-HEAD: C. **HT CABLE 11 KV / 22KV / 33 KV GRADE XLPE INSULATED SINGLE / MULTICORE CABLES - EARTHED**

1. GENERAL

Cables shall be aluminum / copper conductor, XLPE insulated, PVC sheathed, Armoured / Unarmoured and shall be supplied, inspected, laid, tested and commissioned in accordance with drawings, specifications, relevant Indian Standard Specifications and cable manufacturer's instructions.

2. Specification of 11KV / 22KV / 33KV grade Single/Multicore XLPE insulated PVC sheathed Aluminium / Copper conductor Armoured / Unarmoured cables shall be as per IS: 7098 Part-2 **(Un-Earthed Grade):**

a. Conductor :

- Material : Aluminium / Copper
- Shape: Stranded compacted circular aluminium / copper as per Class-2 of IS: 8130.
- Conductor Screening : Extruded semi conducting compound

b. Insulation material : Cross linked polyethylene (XLPE) (Red, Yellow, Blue)
c. Insulation screening : Extruded semi conducting compound followed by helically wrapped 0.050mm thick copper tape
d. PVC Fillers
e. Inner Sheath : Extruded PVC
f. Armouring : Single layer of galvanized steel round wires / flat strips
g. Outer sheath : HR PVC type ST-2 of IS: 5831
h. Colour of sheath : Black

3. TESTS

Cables shall be type tested and routine tested in accordance with IS: 7098 (Part II):

a. Conductor resistance test.
b. Partial discharge test.
c. High Voltage test.

The following tests shall be carried out at site for insulation between phases and between phase and earth before and after cable laying:

a. Insulation Resistance Test.
b. Continuity resistance test.
c. Sheathing continuity test.
d. Earth test.
e. High Voltage test.

4. LAYING OF CABLES

Minimum depth of the cable in the ground shall be 90cm. Laying & Protection of cable shall be as per relevant IS Standards & Codes.
Sufficient cable loops to be left at both the cable ends.

SUB-HEAD: D. 415V, 3 PHASE, 50Hz, 4POLES, CAST RESIN BUSDUCT (IP68)

1. SCOPE:

This specifications covers cast resin IP68 bus bar trunking for interconnection between separate electrical equipment / load centres.

2. GENERAL

- Bus bar Trunking shall be of cast resin type construction. Bus trunking should be waterproof, anti-corrosion, quakeproof. It shall be 3 Phase with 100% Neutral.
- Bus bar Trunking shall be rated for operational voltage of upto 690V with insulation voltage of 1000V and shall be suitable for 50Hz frequency.
- Cast Resin type bus bar shall be suitable for feeder application from 630A to 6300A high electrolytic copper conductor.
- Range shall be suitable for horizontal and vertical application and should be complete with feeder and all accessories like expansion joints, reducers, Tee's etc. as recommended by the manufacturers. Standard length of bus bar shall not be more than 3000mm. Special length shall be designed to connect the end piece and some special requirements.
- Bus Bar Trunking system shall be compact design, suitable for easy installation and there should be no emission of toxicity.
- Ratings of Busway shall be declared as per IEC 61439 and shall be suitable for vertical and/or horizontal installation.
- All indoor/outdoor application shall use IP68 and no GI canopy should be used.
- Bus trunking should pass MSDS test for no emission of toxicity. A valid certificate shall be provided for the same.

3. DESIGN TEMPERATURE & TEMPERATURE RISE

- The Busway ratings shall be declared as per IEC 61439.

4. IP RATING

- The Busduct for indoor/outdoor application shall be IP68.

5. SHORT CIRCUIT AND TYPE TEST

- Busway system shall comply to following new standards:
  IEC 61439, IEC 60529
- Type test certificates including short circuit test according to above standards shall be from international Lab of repute.
- A Type Test report confirming Degree of Protection in accordance with IEC 60529 is must.

6. COPPER CONDUCTOR

Rated Current (A)	Rated Short Time Withstand current (KA) 1s
630A-2500A	As Per BOQ
3200-6300A	As Per BOQ

- The whole bus bar trunking system shall be capable of withstanding the short circuit of the electrical installation without damaging the electrical, mechanical and thermal stress under fault condition at a service voltage of 690V 50Hz. The minimum rated insulation voltage shall be 1000V.

7. HOUSING

- The bus bar trunking housing shall be of cast resin type with enclosure color of light grey/light yellow.
- Housing shall be of resin cast with ease of installation and maintenance.
- The housing shall make use of non-toxic, halogen free refined mixed epoxy resin.
- Housing shall be non-corrosive, high performance with chemical resistance, anti – electromagnetic interference, resistance against animals and insect.
- Color indication (RYBN) should be there on the housing for phase sequence identification.
- The bus bar trunking housing shall be self-cooled with good heat dissipation.
- Also manufacturer to confirm their proposed Housing and construction of housing.
- Totally enclosed resin cast housing for busways shall be manufactured by the busway/busbar trunking system manufacturer. Modifications of bus bar trunking housing at site shall not be acceptable.
- For outdoor/Higher IP protection the housing made by the manufacturer shall be considered based on adequate type test reports ratifying their use in desired conditions/locations alongside a confirmation meeting the requirement of basic IP Protection sought above. External enclosure on the housing shall not be accepted to increase IP.

8. BUS BARS

- Bus bar conductors shall be of high conductivity electrolytic copper.
- Bus bar conductors shall be tin plated at all the ends where joints are connected, to avoid oxidation.
- Bus Bar conductors shall be epoxy resin insulated, providing significant insulation level and resistance to impact, improve life.
- Bus bar trunking for all ratings shall be of cast resin construction, with no air gap between bus bars.

9. NEUTRAL BUS BAR

- Internal neutral conductor shall be 100%, which can meet with the requirements of various power systems in the installations.

10. JOINTS

- The bus bar trunking joint shall be uni-block type with resin cast, which utilizes a high strength steel bolt and washer to maintain proper pressure over a large contact surface area.
- The bolt shall have two-headed design to indicate when proper torque has been applied and should require only a standard long handle wrench for tightening.
- Access shall be required to only one side of the bus bar trunking for tightening joint bolts.
- It should have error proof design to avoid wrong insertion, preventing potential damage on bus bar due to incorrect connection.
- Insulation materials used for joints shall have type test reports confirming resistance to fire.
- Test Report verifying mechanical strength of insulation materials being used and construction of joint is must.

11. TERMINATIONS

- The terminations/ connections of bustrunking to transformers, generators or machines shall be necessarily done using ETP grade laminated copper flexibles of suitable size with tinned ends.

- The terminations of bus trunking on panels or cables can be done using links of Copper tinned end ETP grade copper laminated flexibles.
- The design and size of copper laminated flexibles shall be as per recommendation of manufacturers or their authorized system integrator/ solution provider.

12. HARDWARE FOR TERMINATIONS

- The hardware like nut/bolt/washer shall be high tensile strength 8.8 grade necessarily for transformers, generator and machines ends. However at panel ends 5.6 grade hardware can be used.
- All nuts and bolts used in terminations shall be of high tensile strength and shall follow very reputed makes.

13. SUPPORTS OF BUS BAR TRUNKING

- Hanger spacing shall be noted on layout drawings and shall not exceed manufacturer's recommendations.
- Indoor Feeder bus bar trunking shall be approved for hanger/ wall/floor support spacing of up to 1.5 meters' for horizontally mounted runs and three meters' for vertically mounted runs. Outdoor feeder bus bar trunking shall be approved for spacing of up to 1.5 meters' for horizontally or vertically mounted runs.

The bus bar trunking construction should be such that no two consecutive pieces be installed as successive TOP and BOTTOM, i.e., there should be a clear mechanical preventer to prevent installation of (TOP) RYBN and (BOTTOM) NBYR

14. ENGINEERINGS & INSTALLATION

- The site measurement, design, engineering, drawing preparation of bus trunking layout shall be done wither by manufacturer or their authorized system integrator/ solution providers. The installation, testing & commissioning of bus trunking system shall be done either by manufacturer or their system integrator/ solution provider as per guidelines given by manufacturer. The duly prescribed formats for installation, testing & commissioning shall be submitted before handing over the system to user.
  Proper installation manual shall be provided by the manufacturer before installation. Installation shall be carried out strictly by the approved **SUB-HEAD: F. FINAL DISTRIBUTION BOARDS (FDB's)**

  Final Distribution Boards (FDBs) shall be suitable for operation on 3 Phase/ single phase, 415/ 240 volts, 50 cycles, neutral grounded at transformer. The DB shall be minimum di-electric strength of 2.5 KV for 1 Sec. All Distribution Boards shall manufactured by a manufacturer listed in approved makes of material.

  FDB's shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS: 13947-1993.

1. CONSTRUCTIONAL FEATURES

FDB's shall be made out of 1.6 mm thick high quality CRCA sheet steel and shall be pre-treated and powder coated sheet steel used in the construction of FDB shall be folded and braced as necessary to provide a rigid support for all component. FDB shall be suitable for indoor/ outdoor installation as the case may be, wall mounting or free standing type as per requirement, in double door construction. The Final Distribution Boards shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket, padlocking arrangement. All removable/ hinged doors and covers shall be grounded by 4.0 sqm tinned stranded copper connectors. Final Distribution Boards

shall be suitable for the climatic conditions/ site conditions. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to IS: 8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of FDBs.

Knockout holes of appropriate size and number shall be provided in the FDB's in conformity with the location of cable/ conduit connections. Detachable sheet steel gland plates shall be provided at the top/ bottom to make holes for additional cable entry at site if required.

2. Final Distribution Boards shall comprise of the following:

2.1 A Din Channel for mounting, where appropriate incoming supply circuit breaker & other auxiliaries for Control & distribution as required.

2.2 Installation accessories shall be part of the DB for fixing conductor and rails/ Din Channels for mounting MCB's and RCCB's etc. phase bus bars, neutral bus bars & earthing bus bars as required. All bus bars shall be of tinned copper. MCB's/ ELCB's shall be simply snapped fitted on to a Din Channel and screwed to the bus bar. The arrangement should be such that any MCB can be taken out of without disturbing the other MCB's.

2.3 Service cable/ entry connection shall be part of the Distribution Boards.

2.4 The board shall be installed at a height such that the operating is within reach of the normal human height i.e. 1.2 to 1.8 meters from finish floor level.

2.5 Degree of protection shall be **IP-52 for indoor application, IP-54 for kitchen, laundry, basements/ garages and IP-55 for outdoor application**.

2.6 All three phase distribution boards shall have 4 rows and single phase distribution boards shall have single rows for housing of MCB's and RCCB's unless noted otherwise.

2.7 Phase segregation to be maintained in all three phase distribution boards.

2.8 Earthing shall be provided in each FDB's.

2.9 Where in 3 Phase FDB's, if each phase is controlled by a DP ELCB/ DP RCCB, then a separate neutral link/ bar is to be provided per phase. These will be in addition to the main neutral link/ bar.

2.10 All internal wiring within the FDB shall be with flexible PVC insulated copper conductor wires of adequate size.

2.11 All bus bars including neutral bar/ link shall not be less than 100 Amp, 415 V.

2.12 Main neutral bar/ link and separate neutral link/ bar per phase shall also be of 100 Amp.

2.13 All connections with wires shall be with adequately sized thimbles.

2.14 UPS DB's will have two earth buses i.e. one for body earthing and another for third pin earthing of UPS socket. Dedicated earth bus shall be fixed on the insulated supports.

3 EARTHING

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

4 PAINTING

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivaiting (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of FDB inside/ outside shall be of Siemens gray paint shade no. RAL-7032 of IS Code No.5 or as per Owner/ Architect/ PMC's requirement.

5 LABELS

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

6 TESTING

Testing of FDB's shall be as per following codes:

a. IS: 8623 (Part -I) 1977 for factory built assemblies of switch gear for voltages upto and including 1000 VAC.

b. IS: 13947: 1993 for Degree of protection

7 WIRING

In wiring a FDB, it shall be ensured that total load of various circuits is divided evenly between the phases and number of ways as per Consultants approval.

8.0 Pre-commissioning Test for Final Distribution Boards

PROJECT :
LOCATION :
ARCHITECTS :
PROJECT MANAGERS :
ELECTRICAL CONSULTANTS :
ELECTRICAL CONTRACTORS :

D.B. No. Name : Location :
D.B. Size :
Incomer Cable Size :
3 Phase Incomer MCB/MCCB :
Phase Incomer DP ELCB :

S.No.	Ckt.No.	Wire Size	MCB Rating	I.R. Value (M.Ohm)			Polarity Test	Visual Check	Remarks
				P-N	P-E	N-E			

Particular of Meggar : Meger Sl.No.
Range
Make
Voltage

Name & Designation of Testing Engineer _____
_____

Signature of Testing Engineer _____

Date _____

Note:- Each Final DB to be tested and a Pre-commissioning report to be generated in the format given above.

SUB-HEAD: E1. LT SWITCH GEAR

1. AIR CIRCUIT BREAKERS (ACB)

- The ACB shall confirm to IEC/ IS – 60947-2. The ACB shall have a rated service short circuit breaking capacity (Ics) as specified in SLD's and BOQ "Technical parameters" at rated operational voltage (Ue) at 415V, frequency at 50 Hz. The ultimate breaking capacity (Icu) shall be equal to Service breaking capacity (Ics) and Short Ckt Withstand capacity (Ics=Icu=Icw for 1 see) rated Impulse withstand voltage(Uimp) shall be 12kv and rated insulation voltage (Ui) at 1000V. The ACB release should have true RMS sensing. ACB should have single frame size up to 4000A and shall be suitable for "Switch Disconnect" function (AC 23 utilization category). The construction of circuit breakers shall be as per **pollution degree 3**.
- Circuit breakers shall be three/ four pole, air break, horizontal drawout/ fixed type as indicated in SLD/ BOQ.

- Drawout type Circuit breakers alongwith its operating mechanism shall be provided with suitable arrangement for easy withdrawal. Suitable guides shall be provided to minimize misalignment of the breaker.

- There shall be "SERVICE", "TEST" and "FULLY WITHDRAWN" positions for the breakers. In "TEST" position the circuit breaker shall be capable of being tested for operation without energizing the power circuits i.e. the power contacts shall be disconnected, while the control circuits shall remain undisturbed. Locking facilities shall be provided so as to prevent movement of the circuit breaker from the "SERVICE", "TEST" or "FULLY WITHDRAWN" position. Safety interlock must be provided to prevent the ACB from falling out in a fully withdrawn position. It shall be possible to close the door in "TEST" position.

- Suitable mechanical indications shall be provided on all circuit breakers to show "OPEN", "CLOSE", "SERVICE", "TEST", and "SPRING CHARGED" positions.

- All ACBs should be provided with Microprocessor based release as specified in BOQ/ SLD's should be provided on circuit breaker for short circuit, over current and earth fault protection with adjustable settings with intentional delay. Specific LED indications should be provided for short circuit, over current and earth fault operation for faster fault diagnosis and reduced down time. All ACBs should be provided with "Auto Protection" facility. Opening and closing time of ACB should be <40 m Sec and <70 m sec respectively. All Incomer ACB Release should be provided with display for current and voltage parameters (for each phase & Ground Fault). Control unit shall have fault history data & store **last 10 trip causes**.

  The Circuit Breaker shall have minimum **mechanical life of 10000** operations **without maintenance**.

  The electrical life of circuit breaker upto 2000 Amps shall not be less than 5000 operations and beyond 2000 Amps shall be greater than 1000 operations.

  ACB releases shall be EMI/ EMC compatible. In case of Four Pale ACB, Fully rated Neutral with protection against O/L & S/C with settings at 50%-100%- OFF. ACBs should comply with RoHS. Microprocessor releases shall be provided with integral LCD Display of load current and individual loading of all the three phases. Microprocessor release shall also be suitable for zone selective interlocking (ZSI). Microprocessor releases shall also have I^2t ON/ OFF time delay protection for short circuit and Earth fault.

  All ACBs release shall have in-built thermal memory before and after the fault. ACB release

should be provided with Rotary Dial for release setting. Separate LEDs should be provided on release itself for fault differentiation.

- Relays should be CT operated through shunt trip, under voltage trip for short circuit and earth fault protection.
- Wherever microprocessor earth fault release is asked for. Additional CT shall be provided on the neutral bus link. This CT shall have characteristics matching to the CT's installed in the ACB for the purpose. It should be possible to change the setting of release in "ON" condition.
- All circuit breakers shall be provided with "4 NO" and " 4NC" potential free auxiliary contacts. These contacts shall be in addition to those required for internal mechanism of the breaker and should be directly operated from breaker operating mechanism.
- All circuit breakers shall be provided with the following interlocks :

• Movement of a circuit breaker between "SERVICE" and "TEST" position shall not be possible unless it is in open position. Attempted withdrawal of a closed circuit breaker shall preferably not trip the circuit breaker. In cases the offered circuit breaker trips on attempted withdrawal as a standard interlock, it shall be ensured that sufficient contact exist between the fixed and drawout contact at the time of breaker trip, so that no arcing takes place even with the breaker carrying it's full rated current.

• Closing of a circuit breaker shall not be possible unless it is in "SERVICE" position, "TEST" position or in "FULLY WITHDRAWN" position.

All ACB's shall have **door interlock**

• Circuit-breaker cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage, to cover the stationary isolated contacts when the breaker is withdrawn. It shall however be possible to open the shutters intentionally against pressure for testing purposes.

ACBs shall be provided with a flexibility to rotate power terminals by 90 degree to suite stringent site requirements.

• A breaker of particular rating shall be prevented from insertion in a cubicle of a different rating.

• There should be a provision of positive earth connection between fixed and moving portion of the ACB either through connector plug or sliding solid earth mechanism. Earthing bolts must be provided on the cradle or body of fixed ACB.
• It should be possible to bolt the drawout frame not only in CONNECTED position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.

• Circuit barkers shall provide with castle key/ electrical interlocking devices, as specified in "Bill Of Quantity".

- Mechanical tripping shall be possible by means of front mounted Red "trip" push-button. In case of electrically operated breakers these push buttons shall be shrouded to prevent accidental operation.

The **racking handle shall be stored on the air circuit breaker** in such a manner as to be accessible without defeating the door interlocking.

- Alternatively Means shall be provided to slowly close the circuit breaker in "withdrawn position", if required, for inspection and setting of contacts. In "service position" slow closing shall not be possible.

- All accessories like shunt release, undervoltage, motorized mechanism etc. shall be front mounted, requiring no adjustments and can be fitted at site.

- The manufacturer shall provide details of opening time and duration with temperature to ensure discrimination and proper selection for feeder protections. All ACB's of 4000A and above shall be a single ACB unit. The manufacturer shall also indicate the mechanical and electrical life of circuit breaker.

- Circuit breaker shall be provided with either of the following mechanisms as specified in "Bill Of Quantity".

  The trip unit shall have following protection settings, based on the type of trip unit.

  - Adjustable over load current (Ir) settings from 40% to 100% of rating of ACB (In).
  - Over load time setting (tr) from 0.5s, 1s, 2s, 4s…….24s as field selectable curves
  - Short circuit setting (Isd) from 1.5 to 10 times of Ir setting
  - Short circuit time delay adjustable from 0 to 400 msec.
  - Instantaneous (Ii) protection with an adjustable pick-up and an OFF position.
  - Earth fault setting adjustable in absolute Ampere with time delay settings from 0 to 400 ms.

1.01 Manually Operated Mechanism

- Manually operated mechanism shall be of manual spring charging stored energy type.

- The circuit breaker shall have a spring charging handle and push-button for closing the breaker mechanically after the spring has been charged. However, closing by spring charging handle after the spring has been fully charged shall also be acceptable, provided the movement of contacts does not take place with the movement of handle and the contacts operate only when the spring stored energy is released. Overcharging of spring shall not be possible.

- The closing action of the circuit breaker shall charge the tripping spring, thus making it ready for tripping.

- The circuit breaker shall be provided with the interlocks so that it shall not close unless the spring is fully charged.

- The mechanism shall be suitable for addition of motor mechanism at site if required for future upgrade without the need of any special accessories.

1.02 Power Operated Mechanism

- Power operated mechanism shall be provided with a universal motor suitable for operation on 240 AC/ DC Control supply, with voltage variation from 90% to 110% rated voltage. Motor insulation shall be class "E" or better.

  All ACBs should be provided with "Ready to Close" Contact

- The motor shall be such that it requires not more than 30 seconds for fully charging the

closing spring at minimum available control voltage.

- Once the closing springs are discharged, after one closing operation of circuit breaker, it shall automatically initiate recharging of the spring.

- The mechanism shall be such that as long as power is available to the motor, a continuous sequence of closing and opening operation shall be possible. After failure of power supply at least one open-close-open operation shall be possible.

- Provision shall be made for emergency manual charging and as soon as this manual charging handle is coupled, the motor shall automatically get mechanically decoupled.

- All circuit breakers shall be provided with closing and trip coils (Shunt release + Under voltage release). The closing coil shall operate correctly at all values of voltage between 85% to 110% of rated control voltage. The trip coil shall operate satisfactorily at all values of voltage between 70% to 110% of rated control voltage and shall have continuous rating.

- Provision for mechanical closing of the breaker only in "TEST" and "WITHDRAWN" positions shall be made. Alternately, the mechanical closing facility shall be normally made inaccessible; accessibility being rendered only after deliberate removal of shrouds.

2.00 **Moulded Case Circuit Breakers (MCCB's)**

- The Moulded case circuit Breaker (MCCB) shall confirm to the latest IEC 60947-2 and IEC 947-3-1989. MCCB's shall be suitable for rated operation voltage upto 415 VAC & rated insulation voltage upto 690 VAC.

- MCCB's in AC circuits shall be of triple pole/ four pole construction as per enclosed BOQ. Operating mechanism shall be quick-make, quick-break and trip-free type (Roto-Active design). The "ON", "OFF" and "TRIP" positions of the MCCB's shall be clearly indicated and visible to the operator when mounted as in service. **Front of door operating handle shall be provided with pad lock and door interlock.** Front of door operating handle shall be provided with door interlock defeat mechanism to facilitate inspection of the MCCB during 'ON' position. MCCB shall be suitable for Positive isolation/ disconnection according to IEC 60947-1 & 2 for optimum user safety.

- The Service short circuit Breaking capacity (Ics at 415 VAC) of all MCCB's shall be as specified in SLD/ BOQ and shall have (Ics=Icu=100%).

  All MCCB should have "Class-II" front facia as per IEC 60664.

  Electrical life of MCCB's shall not be less than 10000 operations and mechanical life shall not be less than 20000 operations.

- The MCCB shall be current limiting type. MCCB shall have Arc extinguishing device contained in a compact, high strength, heat resistance, flame retardant, halogen free insulating moulded case with high withstand capability against thermal and mechanical stresses.

- MCCB's shall be either with Thermal-magnetic releases for over load and short circuit or with microprocessor based releases for over load and short circuit as asked for in the BOQ.

  Incase MCCB with Thermal-magnetic releases asked for in the BOQ, shall be provided earth fault module for earth fault protection.

Load indication LED shall be integral part of electronic releases. All electronic releases shall be EMI/ EMC compatible.

- Wherever microprocessor earth fault add on earth fault Module is asked for, additional CBCT shall be provided.

  It should not be possible to bypass/ switch off the S/C, E/F protection in MCCB. The E/F setting should be provided with 10% to 60% with time delay of 0.3 to 3 seconds. LED Indication should be provided in case of earth Fault. **E/F Module should have Test Push Button for self-diagnostic features without tripping the ckt breaker. Also Over current and earth fault differentiation should be provided.**

- The trip command of releases in MCCB shall over ride all the other commands. The MCCB shall employ maintenance free double break contact system to minimize the set through energies and capable of achieving Total Discrimination up to the full short circuit capacity of the downstream MCCB. The MCCB shall not be restricted to line/ load connections. MCCB shall be provided with test trip Push Button to check the proper function of tripping mechanism. MCCB shall comply with RoHS & WEEE norms

- Where Earth fault protection are indicated in drawings/ BOQ they shall be thru Add on Module MCCB's and have adjustability from 10% to 60% of rated current with adjustable time delays to aid discrimination on earth faults. The system shall be immunized against nuisance tripping as per IEC 61000-4 standards.

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- MCCB's shall be capable of withstanding the thermal stresses caused by overloads and locked rotor currents of values associated with protective relay settings of the motor starting equipment and the mechanical stress caused by the peak short-circuit current of value associated with the switchgear rating. The maximum tripping time under short circuit shall not exceed 8 milliseconds.

- MCCB terminals shall be shrouded and designed to receive Bus Bar Links/ cable lugs for cable sizes relevant to circuit ratings.
- The MCCB shall have common field fittable snap-on auxiliaries common for entire range. The remote tripping coil should be of continuous duty cycle.

- Where mechanical interlocking is called-for between two Incomer and Bus Coupler or between two Incomers without Bus Couplers, proper arrangement for built-in Ronis/ Coded key interlocking shall be provided.

3. MOTOR PROTECTION CIRCUIT BREAKER (MPCB)

Motor circuit breakers shall conform to the general recommendations of standard IEC 947 -1,2 and 4 (VDE 660, 0113 NF EN 60 947-1-2-4, BS 4752) and to standards UL 508 and CSA C22-2 N°14. The devices shall be in utilization category A, conforming to IEC 947-2 and AC3 conforming to IEC 947-4.MPCB shall have a rated operational and insulation voltage of 690V AC (50 Hz) and MPCB shall be suitable for isolation conforming to standard IEC 60947-2 and shall have a rated impulse withstand voltage (Uimp) of 6 kV. The motor circuit breakers shall be designed to be mounted vertically or horizontally without derating. Power supply shall be from the top or from the bottom. In order to ensure maximum safety, the contacts shall be isolated from other functions such as the operating mechanism, casing, releases, auxiliaries, etc, by high performance thermoplastic chambers. The operating mechanism of the motor circuit breakers must have snap action opening and closing with

free tripping of the control devices. All the poles shall close, open, and trip simultaneously. The motor circuit breakers shall accept a padlocking device in the "isolated" position.

The motor circuit breakers shall be equipped with a "PUSH TO TRIP" device on the front enabling the correct operation of the mechanism and poles opening to be checked. The auxiliary contacts shall be front or side mounting, and both arrangements shall be possible. The front-mounting attachments shall not change the breaker surface area. Depending on its mounting direction the single pole contact block could be NO or NC. All the electrical auxiliaries and accessories shall be equipped with terminal blocks and shall be plug-in type. The motor circuit breakers shall have a combination with the downstream contactor enabling the provision of a perfectly co-ordinated motor-starter. This combination shall enable type 1 or type 2 co-ordination of the protective devices conforming to IEC 60947-4-1.Type 2 co-ordination shall be guaranteed by tables tested and certified by an official laboratory: LOVAG (or other official laboratory).The motor circuit breakers, depending on the type, could be equipped with a door-mounted operator which shall allow the device setting. The motor circuit breakers shall be equipped with releases comprising a thermal element assuring overload protection and a magnetic element for short-circuit protection. In order to ensure safety and avoid unwanted tripping, the magnetic trip threshold (fixed) shall be factory set to an average value of 12 Ir.

All the elements of the motor circuit breakers shall be designated to enable operation at an ambient temperature of 60°C without derating. The thermal trips shall be adjustable on the the front by a rotary selector. The adjustment of the protection shall be simultaneous for all poles. Phase unbalance and phase loss detection shall be available. Temperature compensation (-20°C to +60°C).

4. MINIATURE CIRCUIT BREAKER (MCB)

- Miniature Circuit Breaker shall comply with IS 8828 – 1996/ IEC 898 – 1995.

- Miniature Circuit Breaker shall be quick make and break type for 230/ 415 V AC and 50 Hz application. The housing of MCB's shall be heat resistant and having a high impact strength. The breaking current of MCB's shall not be less than 10000 Amps, at 230 V/ 415 V. The MCB's shall be flush mounted and shall be provided with trip free manual operating mechanism with mechanical 'ON' and 'OFF' indications. MCB's shall be suitable for isolation function and line load reversibility.

- MCB's shall be current limiting type class – 3. MCB's shall be classified as B, C, and D as per standard Ref. IS as per the Tripping characteristics curves defined by all the manufactures. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/ IEC and the manufactures shall publish the value.

- MCB's shall be calibrated at an ambient temperature of 40 degree.

- The MCB contacts shall be silver nickel alloy and contact tip coated with silver. Proper arc chutes shall be provided to quench the arc immediately. MCB's shall be provided with magnetic coil releases for short circuit protection and thermal release for over load protection. The over load or short circuit devices shall have a common trip bar in the case of DP, TP, TPN and FP Miniature Circuit Breakers and shall have 20000 electrical operations upto 63A. The terminals shall be protected against finger contact to IP 20 Degree of protection.

- MCB's shall have a facility to accommodate accessories like auxiliary contacts, trip alarm contact, shunt trip and under voltage add-on blocks.

Use of MCB's shall be application based i.e.:

For computers/ IT equipment/ Servers	:	Type 'D' characteristics
For motors, inductive loads and Discharge Lamps	:	Type 'C' characteristics
For lighting & small power	:	Type 'B' characteristics

5. RESIDUAL CURRENT CIRCUIT BREAKER CURRENT OPERATED TYPE (RCCB)

- The RCCB/ ELCB should comply with IEC 1008 and shall be suitable for use with pure AC/AC with DC off set, for frequency range of 50 Hz to 400 Hz. The RCCB/ ELCB shall be protected against nuisance tripping by a protective device, limiting such tripping to a peak value of 250 A according to the 8/20 wave for instantaneous devices. RCCB's/ ELCB's shall be suitable for isolation function and line load reversibility.

- EL + MCB/ RCCB shall have Earth leakage, over load and short circuit protection where as ELCB shall have Earth leakage protection only. RCBO/ RCCB wherever provided in Computer systems/ IT equipment's shall be super immunized/ equivalent.

- EL + MCB/ RCCB/ ELCB shall be quick make and break type. The housing shall be heat insulated and having high impact strength. The moving contacts of the Phases shall be mounted on a common bridge, actuated by a rugged toggle mechanism for closing/ opening of all the three phases simultaneously. The neutral moving contact shall be so mounted on the common bridge that at the time of closing, the neutral makes contact first before the phases and at the time of opening, the neutral breaks last after allowing the phases to open first.

- The core balance transformer ensures positive detection of earth leakage currents. The incoming current shall pass through the torroidal core transformer. As long as the current in the phase and the neutral shall be the same, no electromotive force shall be generated in the secondary winding of the transformer. In the event of a leakage to earth, an unbalance shall be created which will cause a current to be generated in the secondary winding, this current shall be fed to a highly sensitive relay, which shall trip the circuit if the earth leakage current exceeds a predetermined critical value. The device shall be current operated independent of the line voltage, current sensitivity of 30mA/ 100mA/ 300mA at 240/ 415V AC as called for in the BOQ.

- EL + MCB/ RCCB/ ELCB shall have trip free nature of mechanism ensuring that it cannot be closed when an earth leakage fault persists.

- Test device shall be there to check the integrity of earth leakage detection system and the tripping mechanism. It shall have box type terminals and capture screws ensuring easy connection of cables and protected against finger contact to IP 20 Degree of Protection.

6. METERS

a. All voltmeters/ multi-function meters and indicating lamps shall be protected through MCB's/ MPCB's depending upon fault level.
b. Meters and indicating instruments shall be flush type.
c. All CT's connection for meters shall be through Test Terminal Block (TTB).
d. CT ratio and burdens shall be as specified on the Single line diagram/ in the BOQ/ as required for the application.

7. CURRENT TRANSFORMERS

Current transformers shall be provided for Distribution panels carrying current in excess of 60 amps. All phase shall be provided with current transformers of suitable VA burden with 5 amps secondary's for operation of associated metering.

The CTs shall confirm to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast robust to withstand thermal and dynamic stresses during short circuits. Secondary terminals of CTs shall be brought out suitable to a terminal block which shall be easily accessible for testing and terminal connections. The protection CTs shall be of accuracy class 5P10 and metering CTs shall be of accuracy class I.

Accuracy class and VA burden shall be as per the application as required as per metering/ protection needs.

8. INDICATING PANEL

All meters and indicating instruments shall be in accordance with relevant Indian Standards. Meters shall be flush mounted digital type. Indicating lamps shall be of low burden, and shall be backed up with 2 amps MCB/ MPCB as per required fault level. Indicating Lamps shall be of LED type. All digital instruments shall have shrouded terminals and suitable for 0°C to 50°C temperature range and shall with stand 1.2 time over loading. Accuracy class and VA burdens shall be as per the requirement. Meters shall be with RS 485 port wherever called for in the BOQ's.

9. SELECTOR SWITCH

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

10. CONTACTOR

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

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

Coil shall be tape wound vacuum impregnated and shall be housed in a thermostatic bobbin, suitable for tropical conditions and shall withstand voltage fluctuations. Coil shall be suitable for 240/ 415 + 10% volts, 50 cycles AC supply. Contactors shall be of 3P/ 4P design as required.

11. THERMAL OVERLOAD RELAY

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

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

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

12. TIME DELAY RELAYS

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

13. TOGGLE SWITCH

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

14. PUSH BUTTON STATIONS

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

15. Coordination Study In LV Network

LV Switchgear Manufacturer shall submit coordinated & Discriminated solution for LV Network protection devices i.e. **ACB, MCCB, MPCB &** MCB for all Incoming and outgoing devices for all Panels/ DB`s as per BOQ with the help of published discrimination tables. Total discrimination shall be provided up to the short circuit breaking capacity of downstream circuit Breakers.

16. CAPACITORS:

16.1 Power Factor Improvement Capacitors:

- The power factor improvement capacitors shall be either heavy duty Dry type MPP (metalized poly propelene type) or Dry type gas filled type (inert gas) as asked for in the BOQ.
- The MPP type capacitors shall be made with impregnation technology. The capacitor shall be made using three capacitor elements wound wired internally in a delta connection with PPMh and positioned inside a metal case. Impregnation shall be Dry resign filled or Gas filled.
- The capacitors shall be meant for continuous duty.
- The operating voltage of capacitors shall be 525V for harmonics environment, where non liner IT loads, VFD's UPS & other similar loads are present.
- The operating voltage of normal application shall be 450V.
- Dielectric losses shall less than or equal to 0.2W/ Watt/ KVAR.
- Capacitance tolerance shall be within the range of – 5 to + 10%.
- The rated frequency shall be 50 Hz ±3%.
- Life expantancy shall be equal to or more than 170000 hours.
- The reference standard for capacitors shall be IEC 831-1/2.
- Capacitors should have high over load capabilities with good thermal & mechanical protections.

16.2 Harmonic circuit filter reactors 7% & 14%:

- Harmonic circuit filters shall be single layer strip would type construction.

- These shall be designed for low loss. Its design shall be step core type for lower losses.
- It shall be vacuum impregnated.
- The class of insulation shall be H class, 180 deg C.
- The reactors are made out of an iron core and air gap.
- It shall have low temperature rise & lower flux density so that it operate in worst conditions of ambient & harmonic loads.
- These should offer good degree of linearity and low losses.
- The filter reactors shall have filtering factor of 7% and 14% as called for in the BOQ.
- These filters are designed for protection of capacitors against Harmonics.

16.3 Automatic power factor correction relay:

- The relay shall be an intelligent relay which should measure, monitor and control reactive energy.
- It shall automatically monitor the power factor, monitor all the connected capacitor steps with real time power in KVAR.

The relay shall be communicable with RS 485 modbus protocol.

SUB-HEAD E2. TYPE TESTED ASSEMBLY PANEL (TTA)

1. SCOPE OF WORK

The vendor scope shall be design, manufacturing, supply, supervision for testing and commissioning of L.T. Panels as per IEC 61439-1&2 for Power & Motor Control Center of Voltages up to 1000 V.

The vendor shall furnish the materials, labour, tools and equipment for installation work, as shown in the accompanying drawings, bill of quantities and specifications hereinafter described.

The drawings, specifications and bill of quantities shall be considered as a part of this scope of work and any work or materials shown on the drawings and not called for in the specifications or vice-versa, shall be considered as if specifically called for in both.

The vendor shall submit the completed data sheet, dimensional drawings and catalogues of switchgears and related brought out items etc. along with quote and detailed general arrangement drawings of the panel within 10 days of signing of the contract for Client/ Consultant's approval.

The GA drawings shall also show all setting out details and physical data/ dimensions of all components used in the system, etc.

2. L.T. SWITCHBOARDS

2.1 General

- The LV switchboards shall be **as per the standards IEC 61439-1&2.** The switchboards and the associated equipment including switchgear, control gear, Busbar supports, Busbar orientation, Busbar links etc shall be identical in construction to the assembly which has undergone the type test. The drawings of the type-tested assemblies shall be made available for inspection. Panel Manufacturer must have an established track record in Design, Manufacturing and Supply of IEC certified Assemblies for at least 10-12 Years.

- The designs of the switchboards should be with switchgear manufacturer, and all the mechanical drawings must be available in the factory beforehand.

- Switchboards shall have a short circuit level withstand as per Schedule of Quantities and drawings.

- The enclosures shall be designed to take care of normal stress as well as abnormal electro-mechanical stress due to short circuit conditions. All covers and doors provided shall offer adequate safety to operating persons and provide ingress protection of IP 4X/ 52 unless otherwise stated. Ventilating openings and vent outlets, if provided, shall be arranged such that same ingress protection of IP 4X/52 is retained. Suitable pressure relief devices shall be provided to minimize danger to operator during internal fault conditions. The compartmentalization to be achieved by using metal separators, use of PVC sheet/ Hylem sheets shall not be allowed.

- Switchboard shall be Internal Arc complied to Internal Arc Resistance as per IEC-61641-V2 rated at 65KA for 0.4 Sec.

- The switchboard along with ACBs and connections should have been be type tested design at CPRI/ Independent international test house for short circuit, temperature rise, protective earth short circuit test and dielectric tests of the ratings required.

2.2 Switchboard Configuration

- The Switchboard shall be configured with Air Circuit Breakers, MCCB's, MCB's and other equipment as called for in the schedule of quantities.

- The MCCBs shall be arranged in multi-tier formation whereas the Air Circuit Breakers shall be arranged in Single or Double tier formation only to facilitate operation and maintenance. In case of double tier ACB arrangement, maximum current rating of vertical dropper shall not exceed 2500A in any case.

- The Switchboards shall be of adequate size with a provision of spare space to accommodate possible future additional switch gear.

- The Switchboard shall be tested for Impulse withstand test at 12KV for all the Panels.

- OEM & Partner's name should be mentioned on Top of each all columns of switchboard.

2.3 Constructional Features

- The Switchboards shall be metal clad totally enclosed, floor mounted free standing type of modular extensible design suitable for indoor mounting.

- Switchboards construction shall employ the principle of compartmentalized and segregation for each circuit.

- Incomer and bus section panels or sections shall be separate and independent and shall not be wired with sections required for feeder. The incomer panel shall be suitable for receiving bus trunking or MV cable of size specified.

- Switchboards shall be made up of requisite vertical sections, which when coupled together, shall form continuous dead front switchboards.

- Switchboard shall be readily extensible on both sides by addition of vertical sections after removal of the end covers.

- The switchboards shall be designed for use in high ambient temperature and humid tropical conditions as specified. Ease of inspections, cleaning and repairs while maintaining continuity of operation shall be provided in the design.

- Metal based neoprene gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust and vermin proof to provide a degree of protection of IP 42/IP 54 as stipulated in schedule of quantities. The unused openings within the switchboards shall be closed using suitable grommets.

- Each vertical section shall be provided with a rear or side cable chamber housing the cable end connections and power/ control cable terminations. There should be generous availability of space for ease of installation and maintenance with adequate safety for working in one vertical section

without coming into contract with any live parts. The design of the switchboard shall allow standard extension chambers if required to accommodate cables.

- Switchboard panels and cubicles shall be fabricated with CRCA Sheet Steel of thickness not less than 2.0 mm and shall be folded and braced as necessary to provide a rigid support for all components. The doors and covers shall be fabricated from CRCA sheet steel of thickness not less than 2 mm. Mounting Plates and internal partition shall be fabricated from Aluzinc sheet of 1.6/2.0mm. Joints of any kind in sheet metal shall be Bolted type. Aluzinc and CRCA sheet shall be tested for Damp Heat and Salt Mist for Aging and Corrosion Resistance of Paint Surface and Metal.

- All panels and covers shall be properly fitted and square with the frame. The holes in the panel shall be correctly positioned.

- Switchboard shall be provided with "Danger Notice Plate" conforming to relevant Indian Standards.

2.4 Switchboard Dimensional Limitations

- The overall height of the switchboard shall be limited to 2400 mm for all the Busbar ratings and type of switchboards. Panel should have integral base frame of 75mm, hence total panel height should not be more than 2275mm.
- The height of the operating handle, push buttons etc shall be restricted between 300 mm and 2000 mm from finished floor level.

- Other dimensional limits if any are specified separately.

2.5 Switchboard Compartmentalization

- For compartmentalized switchboards, separate totally enclosed compartments shall be provided for horizontal busbars, vertical busbars, ACBs, MCCBs, and cable alloys.

- The main board shall be with Form 4b Construction with metallic shrouding only, FRP is not acceptable. Enclosure shall be roughed enough to bear the Seismic Resonance of level Zone-IV. Type test certificate to be submitted for a similar prototype assembly.

- Earthed metal or insulated shutters shall be provided between drawout and fixed portion of the switchgear such that no lives parts are accessible with equipment drawn out. Degree of protection within compartments shall be at least IP 2X.

- Sheet steel hinged lockable doors for each separate compartment shall be provided and duly interlocked with the breaker in "ON" and "OFF" position.

- For all Circuit Breakers separate and adequate compartments shall be provided for accommodating instruments, indicating lamps, control contactors and control MCB etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, busbars and connections.

- For Some MCCB feeders for critical loads like UPS it may be required to have operation only after opening the door, all other facilities like pad lockable rotary handle to be provided for such feeder. It shall be possible to do this change during execution of order

- Each switchgear cubicles shall be fitted with label in front and back identifying the circuit, switchgear type, rating and duty. All operating device shall be located in front of switchgear only. Minimum Height from floor level for any device mounted on panel cover shall be minimum 250mm.

- A horizontal wire way with screwed cover shall be provided at the top to take interconnecting control wiring between vertical sections.
- Separate cable compartments running the height of the switchboard in the case of front access boards shall be provided for incoming and outgoing cables.

- 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.

2.6 Switchboard Bus Bars

- Busbars shall be made of high conductivity, and high strength Aluminum E91 grade Busbars shall be of rectangular cross sections suitable for full load current for phase bus bars and half/ full rated current for neutral bus bar or as stipulated in schedule of quantities. Busbar thickness shall not be more than 6mm for better heat desipation. Busbar shall be suitable to withstand the stresses of fault level as specified in schedule of quantities.

- Main Horizontal busbar and Neutral should be in same compartment.

- The bus bar system may comprise of a system of main horizontal bus bars and auxiliary vertical bus bars run in bus bar alloy on either side in which the circuit could be arranged with front access for cable entrances

- The bus bars shall be supported on non-breakable, non-hygroscopic epoxy resin or glass fiber reinforced polymer insulated supports able to withstand operating temperature of 110 Deg C at regular intervals, to withstand the forces arising from a fault level as stipulated in schedule of quantities. **The material and the spacing of the Busbar supports should be same as in integrated certificate tested as per IEC61439 part-1&2 the type tested assembly. The Bus bar** insulator shall be certified for glow wire test as per IEC-61439.

- All ACB terminals shall have vertical-vertical configuration for termination of incoming & outgoing bus links. All MCCB's upto 630A shall be provided with rear stud type terminations.

- Interleaved Bus Bar arrangement shall be provided for all the panels with bus bar rating of 3200A and above. Distance between bus bar supports shall be inline with type test certificate but shall not exceed 450mm in any case.

- 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. The material for auxiliary supply bus will be insulated electrolytic copper. Wires.

- Clearances between phases should be in line with IEC.

2.7 Switchboard Interconnection

- All connection and tap offs shall be through adequately sized connectors appropriate for fault level at location. This shall include tap off to feeders and instrument/control transformers.

- For unit ratings upto 100 amps, PVC insulated 105 dg withstand, copper conductor wires of adequate size to carry full load current shall be used. The terminations of such interconnections shall be crimped. Solid connections shall be used for all rating of above 100 amps.

- All connections, tappings, clamping, shall be made in an approved manner to ensure minimum contact resistance. All connections shall be firmly bolted and clamp with .even tension. Before assembly joint surfaces shall be filed or finished to remove burrs, dents and oxides and silvered to maintain good continuity at all joints. All screws, bolts, washers shall be zinc plated. Only 8.8 grade nuts and bolts shall be used for busbar connections.

2.8 Drawout Features

Air Circuit Breakers shall be provided in fully drawout cubicles, unless otherwise stated. These cubicles of ACB shall be such that drawout is possible without disconnection of the wires and cables. The power and control circuits shall have self-aligning and self-isolating contacts. Mechanical latches shall be integated in ACB at service, test and isolated position to ensure that Breaker is firmly latched in respective position. It shall not be possible to move the breaker from the position unless latch is manually operated.

2.9 Instrument Accommodation

- Al voltmeter and ammeter and other instruments shall be flushed mounted type of size 96 sq. mm conforming to class 1.5 to IS 1248 for accuracy. All voltmeter shall be protected with MPCBs.

- Instruments and indicating lamps shall not be mounted on the Circuit Breaker Compartment door for which a separate and adequate compartment shall be provided and the instrumentation shall be accessible for testing and maintenance without danger of accidental contact with live parts of the Switchboard.

- For MCCBs, instruments and indicating lamps can be provided on the compartment doors.

- The current transformers for metering and for protection shall be mounted on the solid copper/ aluminium busbars with proper supports.

- On all the incomers of switch boards ON/ OFF indicators lamps shall be provided suitable for operation on AC 230 volts supply. All lamps shall be protected by MCBs.

- For Incomer and important outgoing feeders comprehensive power meters shall be provided which shall display A, V, Pf, Hz, Kw, KVA, KVAr, Kwh, Kvarh, average and maximum values, demand values, THD on current and Voltages. Meter should be provided with RS485 port and should be compatible with BMS/ Scada.

2.10 Wiring

All wiring for relays and meters shall be with PVC insulated copper conductor wires. The wiring shall be coded and labeled with approved ferrules for identification. The minimum size of copper conductor control wires shall be 1.5 Sqmm for Voltage circuit and 2.5 sq. mm. for Current circuit shall be neatly bunched and suitably supported and clamped. Means shall be provided for easy identification of wires. Identification ferrules shall used at both end of wires. All control wires meant for external connections are to be brought out on a terminal board**. The cables and control wires shall be suitable for withstanding 105 deg C.**

2.11 Ventilation Fans

The Switchboard shall be provided with panel mounting type ventilation fans in each panel with switchgear rated for 4500 amp and above. The fan shall be interlocked with switchgear operation. The degree pf enclosure protection to be maintained even with Fans.

2.12 Earthing

Continuous earth bus sized for prospective fault current to be provided with arrangement for connecting to station earth at two points. Hinged doors/ frames to be connected to earth through adequately sized flexible braids.

2.13 Sheet Steel Treatment and Painting

Sheet steel used in the fabrication of switchboards shall undergo On line multi nozzle spray system for each process on the parts hanging from the slow speed conveyor leading to the oven for drying after Pre-treatment as per IS:101-1988. Effective temp and concentration control powder coated for desired shade of RAL 7035. Final paint coat of oven baked powder coating shall be of minimum 60 micron thickness. Powder coated sheet should withstand the 500Hrs of Salt Spray test as per IS: 101-1998.

2.14 Name Plates and Labels

a) One nameplate giving designation of the switchboard shall be affixed prominently on top. Details of designation shall be specified.

b) Labels giving following details shall be affixed on each feeder panel:-
- Feeder No - As per feeder list
- Equipment tag Number and Description
- Rating (KW/ KVA/ AMP)

c) All components whether mounted inside the switchboard or on the door shall be permanently and clearly labeled with reference number and/or letter of their function. These labels should be fixed so that they are easily visible.

d) Labels for feeder panel designation shall be fixed on the front side of respective panels with Special rivet made of nylon. These labels shall be identical size to permit interchange.

2.15 Type test reports

Switchboard configurations offered shall be CPRI/ Independent international test house tested for all the tests as per IEC61439-1 and internal arc tests, impact resistance test. Copies of the test certificates shall be submitted with the tender.

2.16 Testing at Works

Copies of type test carried out at ACB/ MCCB manufacturers works and routine tests carried out at the switchboard fabricators shop shall be furnished along with the delivery of the switchboards. Engineer-in-Charge reserves the right to get the switchboard inspected by their representative at fabricators works prior to dispatch to site to witness the followings.

a) Physical variation and dimensional check
b) Verification of bill of material
c) Functional check
d) HV test
e) IR test

SUB-HEAD: E3. VFD SPECIFICATION

1.0 SCOPE

This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at manufacturer's works, delivery at site, installation, testing, commissioning and carrying out performance test at site of Variable Frequency Drives.

2.0 CODES and STANDARDS

The design, materials, construction features, manufacturer, inspection, testing and performance of variable frequency drives shall comply with all currently applicable statues, regulations, codes and standards in the locality where the system is to be installed. Nothing in this specification shall be construed to relieve the Contractor of this responsibility. In particular, the air distribution system shall conform to the latest edition of following standards.

3.0 GENERAL REQUIREMENTS

- ✓ This specification covers complete variable frequency drives (VFDs) designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD.

- ✓ The frequency converter shall not be a general purpose product, but a dedicated HVAC engineered design.
- ✓ The VFD and its options shall be factory mounted and tested as a single unit under full load before dispatch.
- ✓ The VFD shall be tested to UL 508C. The appropriate UL label shall be applied. VFD shall be manufactured in ISO 9000, 2000 certified facilities.
- ✓ The VFD shall be CE marked and conform to the European Union Electro Magnetic Compatibility directive.
- ✓ The VFD shall be UL listed for a short circuit current rating of 100 kA and labeled with this rating.
- ✓ The manufacturer shall have been engaged in the production of this type of equipment for a minimum of thirty years.

- ✓ The frequency converter shall be supported locally by the manufacturer who will provide full technical support, spares holding and troubleshooting capability from their own local facility. A training course shall be provided by the manufacturer to the consultant/ contractor/ maintenance engineers.
- ✓ To ensure adequate technical and factory support, VFDs manufactured by others and brand labeled shall not be acceptable.

4.0 TECHNICAL REQUIREMENTS

The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating.

When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/ coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.
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The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.
The VFD shall have a dual 5% impedance DC link reactor (harmonic filters) on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable.
VFDs with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.

IEEE519, 1992 recommendations shall be used for the basis of calculation of total harmonic distortion (THD) at the point of common coupling (PCC). On request VFD manufacturer shall provide THD figures for the total connected load. The contractor shall provide details of supply transformer rating, impedance, short circuit current, short circuit impedance etc to allow this calculation to be made.

All VFDs shall contain integral EMC Filters to attenuate Radio Frequency Interference conducted to the AC power line. The VFDs shall comply with the emission and immunity requirements of IEC 61800-3: 2004, Category C1 with 50m motor cable (unrestricted distribution). The suppliers of VFDs shall include additional EMC filters.

The VFD's full load output current rating shall meet or exceed the normal rated currents of standard IEC induction motors. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 second while starting.

The VFD shall provide full motor torque at any selected frequency from 20 Hz to base speed while providing a variable torque V/Hz output at reduced speed. This is to allow driving direct drive fans without high speed derating or low speed excessive magnetization, as would occur if a constant torque V/Hz curve was used at reduced speeds. Breakaway current of 160% shall be available.

A programmable automatic energy optimization selection feature shall be provided as standard in the VFD. This feature shall automatically and continuously monitor the motor's speed and load to adjust the applied voltage to maximize energy savings.

The VFD must be able to produce full torque at low speed to operate direct driven fans.

Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD.

An Automatic Motor Adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to perform the test.
Galvanic isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete digital I/O shall include additional isolation modules.

VFD shall minimize the audible motor noise through the used of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.

The VFD shall allow up to at least 100 meters of SWA (Single Wire Armour) cable to be used between the FC and the motor and allow the use of MICS (Mineral Insulated Copper Sheath) cable in the motor circuit for fire locations.

5.0 PROTECTIVE FEATURES

A minimum of Class 20 I^2t electronic motor overload protection for single motor applications shall be provided. Overload protection shall automatically compensate for changes in motor speed.

Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not acceptable.

Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.
Protect from under voltage. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output, without faulting, with an input voltage as low as 70% of the nominal voltage.

VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.

If the temperature of the VFD's heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD's temperature becomes too high.

In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output current to a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.

The VFD shall have temperature controlled cooling fan(s) for quiet operation, minimized losses, and increased fan life. At low loads or low ambient temperatures, the fan(s) may be off even when the VFD is running.

Protect from output switching: The VFD shall be fully protected from switching a contactor / isolator at the output without causing tripping e.g.: for switching on/off the isolators of the AHU / ventilation fans / pumps near the motor with VFD in ON mode.

The VFD shall store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm shall be recorded.

When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.

6.0 INTERFACE FEATURES

Hand, Off and Auto keys shall be provided on the control panel to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or password protect them from undesired operation.

There shall be an "Info" key on the keypad. The Info key shall include "on-line" context sensitive assistance for programming and troubleshooting.

The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in Hand or Auto mode. This is to alert the Building Automation System whether the VFD is being controlled locally or by the Building Automation System.

Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted. Two levels of password protection shall be provided to guard against unauthorized parameter changes.

All VFDs shall have the same customer interface. The keypad and display shall be identical and interchangeable for all sizes of VFDs.

To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters. Keypad shall provide visual indication of copy status.

Display shall be programmable to communicate in multiple languages including English, Chinese, Korean, Japanese, Thai and Indonesian.

A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.
A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD. The VFD shall also have individual Fan, Pump, and Compressor menus specifically designed to facilitate start-up of these applications.

A three-feedback PID controller to control the speed of the VFD shall be standard.

This controller shall accept up to three feedback signals. It shall be programmable to compare the feedback signals to a common setpoint or to individual setpoints and to automatically select either the maximum or minimum deviating signal as the controlling signal. It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.

The VFD shall be able to apply individual scaling to each feedback signal.

For fan flow tracking applications, the VFD shall be able to calculate the square root of any or all individual feedback signals so that a pressure sensor can be used to measure air flow.

The VFD's PID controller shall be able to actively adjust its setpoint based on flow. This allows the VFD to compensate for a pressure feedback sensor which is located near the output of the pump rather than out in the controlled system.

The VFD shall have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide setpoint reset.

Floating point control interface shall be provided to increase/ decrease speed in response to contact closures.

Five simultaneous meter displays shall be available. They shall be selectable from (at a minimum), frequency, motor current, motor voltage, VFD output power, VFD output energy, VFD temperature in degrees, feedback signals in their own units, among others.

Programmable Sleep Mode shall be able to stop the VFD. When its output frequency drops below set "sleep" level for a specified time, when an external contact commands that the VFD go into Sleep Mode, or when the VFD detects a no-flow situation, the VFD may be programmed to stop. When the VFD's speed is being controlled by its PID controller, it shall be possible to program a "wake-up" feedback value that will cause the VFD to start. To avoid excessive starting and stopping of the driven equipment, it shall be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD.

A run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output "run request" signal to indicate to the external equipment that the VFD has received a request to run.

VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (°F). Examples can be room temperature in ^{0}C, return air temperature in ^{0}C, supply air temperature in ^{0}C, CO_2 concentration in ppm, pressure in bar, differential pressure in PSI etc.

VFD shall be programmable to sense the loss of load. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.

Standard Control and Monitoring Inputs and Outputs

Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.

Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.

Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.

Each relay shall have an adjustable on delay/ off delay time.

Two programmable analog inputs shall be provided that can be either direct-or-reverse acting.
Each shall be independently selectable to be used with either an analog voltage or current signal.

The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.

A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.

The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting, One programmable analog current output (0/4 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output. It shall be possible to read the status of all analog and digital inputs of the VFD through serial bus communications. It shall be possible to command all digital and analog output through the serial communication bus. Optional Control and Monitoring Inputs and Outputs. It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.

These modules shall use rigid connectors to plug into the VFD's control card.

The VFD shall automatically recognize the option module after it is powered up. There shall be no need to manually configure the module.
Modules may include such items as:
Additional digital outputs, including relay outputs
Additional digital inputs
Additional analog outputs
Additional analog inputs, including Ni or Pt temperature sensor inputs

It shall be possible through serial bus communications to control the status of all optional analog and digital outputs of the VFD.

Standard programmable firefighter's override mode allows a digital input to control the VFD and override all other local or remote commands. It shall be possible to program the VFD so that it will ignore most normal VFD safety circuits including motor overload. The VFD shall display FIREMODE whenever in firefighter's override mode. Fire mode shall allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accommodate local fire codes, standards and conditions.

A real-time clock shall be an integral part of the VFD.
It shall be possible to use this to display the current date and time on the VFD's display.

Ten programmable time periods, with individually selectable ON and OFF functions shall be available. The clock shall also be programmable to control start/ stop functions, constant speeds, PID parameter setpoints and output relays. Is shall be possible to program unique events that occur only during normal work days, others that occur only on non-work days, and others that occur on specific days or dates. The manufacturer shall provide free PC-based software to set up the calendar for this schedule.

All VFD faults shall be time stamped to aid troubleshooting.
It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.

The real-time clock shall be able to time and date stamp all faults recorded in the VFD fault log.
The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.

The VFD shall include a sequential logic controller to provide advanced control interface capabilities.

This shall include:
Comparators for comparing VFD analog values to programmed trigger values
Logic operators to combine up to three logic expressions using Boolean algebra
Delay timers
A 20-step programmable structure

The VFD shall include a Cascade Controller which allows the VFD to operate in closed loop set point (PID) control mode one motor at a controlled speed and control the operation of 3 additional constant speed motor starters.

7.0 SERIAL COMMUNICATIONS

The VFD shall include a standard EIA-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:
Metasys N2
Modbus RTU

VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD. The manufacturer shall provide no-charge PC software to allow complete setup and access of the VFD and logs of VFD operation through the USB port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.
The VFD shall have provisions for an optional 24 V DC back-up power interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.

8.0 ADJUSTMENTS

The VFD shall have a manually adjustable carrier frequency that can be adjusted in 0.5 kHz increments to allow the user to select the desired operating characteristics. The VFD shall also be programmable to automatically reduce its carrier frequency to avoid tripping due to thermal loading. Four independent setups shall be provided.

Four preset speeds per setup shall be provided for a total of 16.

Each setup shall have two programmable ramp up and ramp down times. Acceleration and deceleration ramp times shall be adjustable over the range from 1 to 3,600 seconds.

Each setup shall be programmable for a unique current limit value. If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will cause the VFD to reduce its output frequency to reduce the load on the VFD. If desired, it shall be possible to program a timer which will cause the VFD to trip off after a programmed time period.

If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under-voltage, over-voltage, current limit, over temperature, and VFD overload.

The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.

An automatic "start delay" may be selected from 0 to 120 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply a DC braking current if desired.

Four programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment shall be provided. Semi-automatic setting of lockout ranges shall simplify the set-up.

9.0 OPTIONAL FEATURES

All optional features shall be built and mounted by VFD manufacturer as an inbuilt factory solution. All optional features shall be UL listed by the VFD manufacturer as a complete assembly and carry a UL label.

10.0 SERVICE CONDITIONS

Ambient temperature at full speed, full load operation with continuous drive rated output current:
-10 to 45°C for ratings upto 90 kW without derating
-10 to 40°C for ratings 110 kW and higher without derating

Relative Humidity: 0 to 95%, non-condensing.
Elevation: Up to 3,300 feet without derating.
AC line voltage variation: ± 10% of nominal with full output.
VFD Enclosure protection: IP 20 with Mains Disconnect switch, integral, with no additional cabinets. – Not applicable. Protection shall be for Indoor installation.

Side Clearances: No side clearance shall be required for cooling.
All power and control wiring shall be done from the bottom.
All VFDs shall be plenum rated.

All the contacts mounted on each VFD should be brought to the terminal blocks of each starter in order to enable BMS vendor to do termination of his cables. None of the terminations of the BMS cables be done directly to the VFD.

11.0 QUALITY ASSURANCE

To ensure quality, the complete VFD shall be tested by the manufacturer. The VFD shall drive a motor connected to a dynamometer at full load and speed and shall be cycled during the automated test procedure.
All optional features shall be functionally tested at the factory for proper operation.

12.0 SUBMITTALS

This specification lists the minimum VFD performance requirements for this project. Each supplier shall list any exceptions to the specification. If no departures from the specification are identified, the supplier shall be bound by the specification.

13.0 ADDITIONAL NOTES

- VFD's should have inbuilt DC choke.
- THDI on current side shall be limited to 35% (Total harmonics distortion).
- VFD's shall be complete with EMC filters.
- VFD's to work with input voltage variation of 415V ± 10%
- IP 20 for installation inside panels.
- In open : IP 55

SUB-HEAD: F. **CONSTRUCTION FEATURES & GENERAL NOTES OF LOW VOLTAGE MAIN AND SUB DISTRIBUTION BOARDS/ PANELS/ SWITCH BOARDS/ METER BOARDS/ ACB ISOLATOR PANELS/ MOTOR CONTROLS CENTRES (MCC)**

GENERAL SPECIFICATIONS

Main & Sub Distribution Boards shall be classified as FBA (Factory Built Assemblies) as per IS: 8623:1998/ IEC: 60439 Part-I of Cubicle type, Sheet steel clad, Totally enclosed, Dust & Vermin proof, Indoor type/ outdoor type, Rigid, Free standing, Floor mounted compartmentalized, Single front for use on 415 volts, 3 phase, 50 cycles, AC system with a fault level withstand capacity as per B.O.Q./ as required, RMS Symmetrical. Complete with busbars interconnections, power, control/ auxiliary circuits/ wiring & earthing. With powder coated paint finish, switchgear as per B.O.Q of approved makes specified.

BASE FRAME: 3MM
Normal Indoor Application: CRCA
Outdoor Application: GI
Sheet Type: PN02/ Equivalent as approved
Sheet Make: TISCO/ Equivalent as approved

STRUCTURE, COVER BACK & FRONT DOOR: 2MM
Normal Indoor Application: CRCA
Outdoor Application: GI
Sheet Type: PN02/ Equivalent as approved
Sheet Make: TISCO/ Equivalent as approved

PARTITIONS: 1.6MM
Normal Indoor Application: CRCA
Outdoor Application: GI
Sheet Type: PN02/ Equivalent as approved
Sheet Make: TISCO/ Equivalent as approved

GLAND PLATES: 3MM
Multi Core Cables: CRCA
Single Core Cables: Aluminum

MOUNTING PLATES: 2MM
Normal Indoor Application: CRCA
Outdoor Application: GI
Sheet Type: PN02/ Equivalent as approved
Sheet Make: TISCO/ Equivalent as approved

CONSTRUCTION
Completely modular & compartmentalized, form 3B separation. Separate adequately spaced Unit Chamber, Bus bar & cable compartments.

EXTENSIBILITY
Readily extensible on both ends.

Panels should be made in easily transportable sections.

DIMENSIONS

Operating height	1800mm max. 300mm min.
Overall height	2400mm max.
Compartment size HXW	225mm x 500mm min
Cable chamber	300mm min.

DEGREE OF PROTECTION

IP: 42 for totally Indoor application.

- Panels in Substation area, Electrical Rooms, LT Panel Rooms & DG Set Room
- MDB L+P Panel
- Tower Panel
- EWS Panel
- Meter Boards (In Electrical Rooms)
- Lift Panel (In Lift Machine Room)
- AHU Panel
- Basement Ventilation Panel
- Staircase & Liftwell Pressurization Fan Panel (If Indoors)

IP: 54 for Indoor Application

- Plumbing Panel
- Fire Pump Panel
- STP Panel
- AC/ Chiller Panel
- Chiller Auxiliary Panel
- DG Set Auxiliary Panel
- Laundry Panel
- Kitchen Panel

IP: 55 for Outdoor Application.

- Feeder Pillar
- Outdoor Junction boxes
- Outdoor boards/ panels
- ACB Isolators (outdoors)

All outdoor IP 55 panels shall be:

a. Double door design
b. With canopy
c. In GI sheet steel construction in place of CRCA sheet steels to avoid rusting.
d. Panel shall have forced ventilation mechanism with Rital fan & filter section, to avoid temperature rise and at the same time maintaining IP 55 integrity.

DOOR HINGES

Concealed, Powder Painted

DOOR LOCKS

Zinc alloy powder painted with provision for pad locking..

GASKET
Neoprene/ PE foam of suitable profile to provide desired degree of protection.

LIFTING ARRANGEMENT
Eye bolt of removable design, when removed these shall not leave any opening in the boards.

PAINTING
Pre-treatment eight tank process or on line automatic spray system with oven for drying after Pre-treatment as per IS: 101-1988 effective temperature and concentration control. Powder coating of desired shade as per requirement. Paint thickness min. 60 micron

CORROSSION RESISTANCE
Withstand 500 hrs of Salt Spray as per IS: 101-1988

BUS BARS MAIN
Aluminum E-91E grade, min. 53% IACS
Copper min 99% IACS (Tinned copper)
Configuration: Interleaved 2000A & above

Minimum clearances shall be:

Phase to Phase	32mm
Phase to Neutral	25mm
Phase to earth	25mm
Neutral to earth	25mm

BUS BARS EARTH
As per material of main busbar of size suitable to withstand fault level specified/ as required. Continues length of earth bus to be provided.

UPS Output Panels shall have two earth bars of tinned copper of suitable rating. One of the earth buses shall be dedicated i.e. mounted on insulated supports.

BUS BAR TEMP. RISE
Ambient $45^{o}C$
Maximum bus bar temperature rise 40^{o} C over ambient
No deration of Switchgear & Panels upto $45^{0}C$

BUS BAR SIZING/ CROSS-SECTION
Bus bars to be sized to carry the full rated load current without exceeding maximum temperature rise as limited above. Bus bar size calculations to be submitted with shop drawings. Busbars to withstand the maximum short circuit current as specified/ as per requirement.

BUS BAR SUPPORTS
Non Hygroscopic Epoxy/SMC at suitable distance to withstand forces of short circuit as per requirement.

BUS BAR INSULATION
Black heat shrinkable, fire retardant, self extinguishing type sleeves suitable to withstand $110^{o}C$
Colour coding to be followed as per IS codes. Phase sequences and polarity to be followed as per IS codes.

SHROUDING

All live parts should be shrouded with IP2 protection Fire Retardant, Non Inflammable, Non Hygroscopic e.g. Polycarbonate, FRP.

HARDWARE

High tensile for ACB & ACB Bus termination Joints
Corrosion resistance, Cadmium plated for other joints
All bolts with spring/ star washer

WIRING
1100V Fire retardant, virgin PVC color coded flexible wire

Voltage circuit	1.5 sq mm
Current circuit	2.5 sq mm
Earth circuit	2.5 sq mm

As per IS: 694

WIRING IDENTIFICATION
Computerized ferrule on both ends as per IS: 375

TERMINAL BLOCK
Power - Melamine stud type.
Control - Polyimide color coded screw less clamp fit type.
Not more than one wire connected to one terminal block.
Plug in type terminal block at each transport section.

COMPONENT LEGEND
Computerized labels for all control component & terminal block

FEEDER DESCRIPTION PLATES
Powder coated Al. Plate with computerized printing, size:
MDB = 150 x 50 min
S/DB = 100 x 40 min

SPARE FEEDERS
It shall be as per B.O.Q./ SLD. If B.O.Q/ SLD does not specify anything, than an average of 20% of a mix of various ratings/ feeders to be provided as spare feeders in each board/ panel. Spare feeders must include a minimum one biggest and a minimum of one smallest rated feeders as spares along with other spares.

CABLING
Provision for top/ bottom/ top & bottom entry of cables, as per requirement/ as per site. Adequately sized cable chambers. Easy and safe termination & maintenance facility.

BUS TRUNKING TERMINATION
Wherever specified in B.O.Q power connection arrangement at top suitable for bus trunking.

SWITCHGEAR
As per specification & Makes specified. IS: 13947 I- IV, 1993
Only one make of switchgear to be used in a board/panel. The switchgear selection shall be as per manufacturer's co-ordination tables.

CONTROL COMPONENTS
As per specification & Makes specified. IS: 13947 I - IV, 1993

INDICATING INSTRUMENTS
Analog/ Digital as per specifications, notes, B.O.Q. & Makes specified. IS: 13779

BMS compatible multifunction meters shall be complete with communication card, shall be net-workable and shall be wired on to common RS 485 Bus and information from these meters to BMS to be released at one point.

INDICATING INSTRUMENTS ACCESSORIES
CT/PT-Cast resin as per specifications & make specified. IS: 2705, 1992

CONTROL MCB'S/ MPCB'S
For control and metering circuit/ wiring, these shall be of fault level as required.

SPACE HEATER
All ACB Incomer & bus couplers shall be provided with Space Heater & Thermostat & 11 watt panel illumination. Heaters shall be controlled by a 6A MCB/ MPCB as per the required fault level.

SHOP DRAWINGS
Notes, General arrangement, Elevations, Single line diagram, Bill of material, Control and inter locking scheme to be submitted for approval prior to manufacturing and approval taken from PMC/ Consultant/ Owner.

TESTING & PRE-DISPATCH QUALITY CONTROL

A. Fabrication, Pre-treatment, painting, assembly and wiring.

B. **Tests**:

- Physical, Electrical and Operational tests of all Breakers/ Switches.
- Operational check of all meters and relays.
- Dielectric strength test for insulation at 2.5kV for 1 sec.
- Insulation resistance test at 1000V megger,
- Protective measures and continuity of circuits, as per IS: 8623-I, 1993.
- Testing of protection relays by secondary injection kit before commissioning.
- Interlocking Function Test.
- Earth continuity test between various Non-current carryings parts of equipment steel work etc. & the earth bus provided in the panel.

INSPECTION
To be offered at works to PMC/ Owner.

TEST CERTIFICATE TYPE AND ROUTINE
Test results for routine tests conducted at works should be submitted. Type tests as per IS: 8623 - Part I for Short circuit, Temperature rise, Degree of protection to meet the specifications and B.O.Q must be furnished.

PACKING
Wooden Crates/ Wooden Cases/ Polythene & Water proof paper to be used.

AS MANUFACTURED DRAWINGS

To be submitted in CD format with catalogues and test certificates of switchgear, controlgear and other components used within MDB & PDB.

AFTER SALES SERVICE

Manufacturer to have an Independent department to render after sales support for Installation, commissioning & trouble shooting during and after warranty period.

OPERATING CONDITIONS:

- No De-ration of panels, Switchgear/ Equipment & Busbars upto 45 Deg. C & Altitude of 1000M above MSL for indoor panels**.**
- No De-ration of panels, Switchgear/ Equipment & Busbars upto 50 Deg. C & Altitude of 1000M above MSL for outdoor panels/ feeder pillars.

CONNECTION BETWEEN BUSBARS & SWITCHGEAR

- Upto 63Amp Switch rating with 1.1 KV grade FRLS PVC insulated flexible single core copper cables. Tinned copper or silver plated copper lugs shall be used on copper wires.
- Above 63Amp Switch rating, with solid aluminium/ copper busbar links, to be used.
- Neutral Bus bars for four pole feeders shall be of the same size as phase.
  Neutral Bus bars for triple pole feeders shall be of 50% size of phase.
  Neutral Bus bars for UPS panels shall be of 200% size of phase.

IMPORTANT NOTE: VENDORS TO SUBMIT SWITCHGEAR SELECTION/ RATINGS FOR ALL THE PANELS ALONG WITH THE BID.

SUB HEAD: G: <u>24 VOLTS DC BATTERY CHARGER</u>

a. Scope:

This section covers supply, installation, testing and commissioning of Battery and Battery charger.

b. 24 volts DC battery:

12 volts each 180AH, (25 plates battery each) batteries comprising of 2 Nos. standard lead acid stationary tubular type batteries.

i. MS painted/ powder coated battery enclosure with rubber pads or spill proof plastic trays.
ii. Set of connectors with ends take-off suitable for connections.
iii. Spring type hydrometer.

c. Battery charger:

Battery float cum boost charger of continuous load current plus boost charge current & capable of achieving required specific gravity & suitable for charging batteries. The charger shall have following accessories:

i. 1 No. rotary switch to select auto float/ manual float/ manual boost. During auto float mode automatic changeover shall take place from float mode to boost mode and vice versa.
ii. Single phase double copper wound impregnated naturally air cooled mains transformer.
iii. 1 Set solid state constant potential controller to stabilize the DC output voltage of the float cum boost charger at + 2% of time set value of AC input voltage variation of 230V±10%, frequency variation of ±5% from 50Hz and simultaneous load variation of 0-100% and also complete with Current Limiting Circuit to drop the Float Charger output voltage upon overloads to enable the battery to take over.
iv. 1 No. electronic controller to automatically changeover battery charging from boost to float and vice versa.
v. 1 No. DC ammeter and toggle switch to read charger output current and battery charge/ discharge current.
vi. 1 No. moving coil DC voltmeter to read the DC output voltage.
vii. 2 Sets potentiometer to adjust the output voltage during manual/ auto float and boost modes.
viii. 1 No. double pole ON /OFF MCB for Charger Output (24V DC rating)
ix. 2 Sets DC output terminals. 1 set for the load and the other set for the battery.

Alarm annunciation: Visual and audible alarm with manual accept reset facility shall be provided for the following:

a. AC mains failure
b. Charger Failure
c. Load/ Output over voltage

Rating:

AC Input	230±10% AC 50Hz single phase.
DC output	To float/ boost charge 24V suitable rating batteries and also supply a continuous load.
Current Rating	As battery rating
Float Mode	27.0V nominal (adjustable) between 24-28.0V
Boost Mode	28.2V nominal (adjustable) between 24-29.0V
Voltage regulation	±2% for AC input variation of 230V ± 10%. Frequency variation of 50Hz±5% and DC load variation 0-100%
Ripple	Less than 5%

SUB-HEAD: H. LT CABLES - 1.1 KV GRADE

1. GENERAL

The cables shall be supplied, inspected, laid, tested and commissioned in accordance with drawings, Specifications, relevant Indian Standard and cable manufacturer's instruction.

2. MATERIAL

2.1 XLPE INSULATED CABLES

Specification of 1.1KV grade Single/ Multicore XLPE insulated, PVC sheathed Aluminium/ Copper conductor Armoured/ Unarmoured cables shall be as per IS: 7098 Part-1:

i. Conductor:

- Material : Aluminium / Copper : Electrolytic grade
- Shape : Aluminium conductor : 6 & 10 sqmm. Solid circular
  : 16 sqmm. & above stranded compacted shaped
  : Copper conductor : 4 & 6 sqmm. stranded non compacted circular
  : 10 sqmm. stranded compacted circular
  : 16 sqmm. & above stranded compacted shaped

ii. Insulation Material : Cross linked polyethylene XLPE (Red, Yellow, Blue & Black)
iii. Inner Sheath : Extruded inner PVC sheath
iv. Armouring : Single layer of galvanized steel round wires / flat strips
v. Outer sheath : FR-LSH PVC Sheath
vi. Colour of sheath : Black

Note: Single core armoured cables shall be with "Non-magnetic" type armouring.

2. FIRE SURVIVAL CABLES

i. Voltage Grade: Up to 1000 V
ii. Designed as per IEC 60502-1:2004/ BS 7846:2009
iii. Cable Size: Up to 4 Cores, 10 sq. mm. to 400 sq. mm. aluminium and 1.5 Sq.mm. to 400 Sq.mm. copper.
iv. Conductor Type: Stranded Circular Aluminium/ Copper.
v. Construction: Class 2
vi. Insulation Material: Glass Mica + Ethylene Propylene Rubber
vii. Sheathing Material: Special Low Smoke Zero Halogen Compound
viii. Armour: Galvanized Steel
ix. Colour Codes: As per customer's requirement
x. Fire Resistance: BS 8491/ BS 8434-2/ BS EN 50200 + Annex. E/ IEC 331:2009 (1&2)/ BS 6387 CWZ
xi. Low Smoke Emission: Light Transmittance > 60 % as per IEC 61034
xii. Flame Retardant: As per IEC 60332
xiii. Halogen Free: Acid Gas Less than 0.5 % as per IEC 60754
xiv. Min. Bending Radius: 12 x O.D.

Fire Survival/ Resistance circuit integrity armoured cable of 600/1000V rated with Copper/ Aluminium Circular conductors having Glass Mica (Fire barrier) tape covered by an extruded layer of

crosslinkable high module Ethylene Propylene Rubber (HEPR) insulation and LSZH inner & outer sheath. Basic design as per BS 7846 for copper cables, IEC-60502-1 for aluminium cables. Should retain circuit integrity as per Category-3 of BS:8519 when tested in accordance to BS 8491 for power cables having overall diameter of 20mm and above & BS EN 50200 PH-120 for control cables having overall diameter less than 20mm. Type test reports of each lot from 3rd party inspection agency required prior to despatch.

Fire Survival/ Resistance Armoured Cable with Aluminium/ Copper Conductor having Glass Mica (Fire barrier) tape covered with crosslinkable high module Ethylene Propylene Rubber (HEPR) insulation and LSZH inner and outer sheath. Basic design as per BS-7846 for copper and IEC -60502-1 for aluminium (Latest Editions).

The cables should meet circuit integrity at 1000 volts with simultaneous action of Fire, Impact & water on single sample when tested in accordance to category-3 of BS 8519:2010 when tested in accordance to BS 8491 & BS EN 50200 PH-120.

The cables should not emit toxic gases in case of fire. The toxicity index should be less than 3 (refer NES 713).

The cables should comply with the requirements of IEC-61034 Part 1&2 (Measurement of Smoke density of cables burning under defined conditions).

The cables should comply with the requirements of BS EN 60754 (Determination for amount of halogen acid gas content which shall not be greater than 0.5%)

Fire & type test reports of each lot from 3rd party inspection agency required prior to despatch.

3. CABLE LAYING AND HANDLING

It should be ensured that both ends of the cable are properly sealed to prevent ingress/ absorption of moisture.

4. CABLE HANDLING

When cable drums have to be moved over short distance, they should be rolled in the direction of the arrow marked on the drum.

While removing cables, the drums shall be properly mounted on jacks or on a cable wheels or any other suitable means, making sure the spindle, jack etc. are strong enough to take the weight of the drum.

The cables shall not be given a sharp bend to a small radius. The minimum safe bending radius for all types of PVC/XLPE cables shall be taken as 12 times the overall diameter of the cable. Wherever practicable, larger radius should be adopted. At joints and terminations, the bending radius of individual cores of a multicore cable shall not be less than 15 times its overall diameter.

Cable with kinks and straightened kinks, or with similar apparent defects like defective armoring etc. shall not be installed/ laid.

Cables of different voltages as well as power and control cables should be kept in different trenches/ racks with adequate separation. Where available space is restricted, LV/MV cable shall be laid above HV cables.

Where cables cross over cannot be avoided, the cable of higher voltage shall be laid at a lower level than the cable of lower voltage.

Installation of cables including jointing shall be carried out as per IS: 1255 amended and revised to date.

Power and communication cables shall, as far as possible cross at right angles. Where power cables are laid in proximity to communication cables, the horizontal and vertical clearances shall not normally be less than 60 cm.

Cables shall be laid direct in ground, in pipes/ closed ducts, in open ducts or on surface depending on environmental conditions, and as required in schedule of quantities.

During the preliminary stages of laying the cable, consideration should be given to proper location of the joint position so that when the cable is actually laid, the joints are made in the most suitable places and as approved by Consultant. As far as possible, water logged locations, carriage ways, pavements, proximity to telephone cables, gas or water mains, inaccessible places, ducts, pipes, racks, etc. shall be avoided.

The cable shall not in any circumstances be bent so as to form an abrupt right angle but must be rounded off at the corners to a radius not less than 12 times the overall diameter of the cable.
In case, where there are chances of any damage to the wiring/ cables, such wiring/ cables shall be covered with a sheet metal protective covering (not less than 16 SWG), the base of the covering being flush with the plaster or brickwork as the case may be, or the wiring/ cables shall be drawn through a heavy gauge metal conduit pipe by complying with all the requirements of conduit wiring system.

Such protective covering shall, in all cases, be fitted on all down drops within 1.5 m from the floor or from floor level upto the switch board, whichever is less.

While cutting and stripping of the outer sheathing of the cable, care shall be taken that the sharp edge of the cutting instrument does not touch the inner insulation of the conductors. The protective outer covering of the cable shall be stripped off near connecting terminal and this protective covering shall be maintained upto close proximity of connecting terminals. The cables laid near junction boxes shall be made moisture proof with a plastic compound.

5. CABLE JOINTING & TERMINATION

Jointing shall be as per the manufacturer's recommendations using standard kits. Cable joints shall be made in suitable, approved cable joint boxes, jointing of cables in the joint boxes and filling of compound shall be done as per manufacturer's recommendations. Heat shrinkable joints shall be made.

Cables shall be terminated onto the terminals of switchgear through crimping lugs of proper size and of heavy duty. Cable lugs shall be fitted onto the cable by crimping or compression jointing.

Continuity of cable armouring is to be maintained. Double compression glands to be used. Proper crimping tools to be used.

6. TRENCHING & CABLE LAYING

The minimum width of trench shall be 45 cm and depth shall be 75cm for laying of cable. Where more than one cable is to be laid in the same trench in horizontal formation, the width of trench shall be increased such that the minimum gap between the cables is one diameter of the cable unless specified otherwise.

The clearance between axis of the end cables and the sides of the trench shall be minimum 1.5 D (diameter) of the end cable.

The trenches shall be excavated in reasonably straight lines. Wherever there is a change in direction, suitable curvature shall be provided.

Where gradients and changes in depth are unavoidable, these shall be gradual.

The bottom of the trenches shall be level and free from stone, brick bats etc. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 9 cm in depth.

Cable laid in trenches in a single tier formation shall have a covering of clean, dry sand of not less than 20 cms. above the base cushion of sand before the protective cover is laid.

In the case of vertical multi-tier formation, after the first cable has been laid, a sand cushion of 30 cms shall be provided over the initial bed before second tier is laid. If additional tiers are formed, each of the subsequent tiers shall have a sand cushion of 30 cms as stated above. The top-most cable shall have final sand covering not less than 17 cms before the protective cover is laid.

Unless otherwise specified, the cables shall be protected by second class bricks of not less than 20 cm x 10 cm x 10 cm (nominal size) as per CPWD building specification, or protection covers placed on top of the sand, (brick to be laid breadth wise) for the full length of the cable to satisfaction of the owner. Where more than one cable is to be laid in the same trench, this protective covering shall cover all the cables and project at least 5 cm over the sides of and cables.

The trenches shall be then back filled with excavated earth free from stone or other sharp-edged debris and shall be rammed and watered, if necessary, in successive layers not exceeding 30 cm. Unless otherwise specified, a crown of earth not less than 50 mm in the center and tapering towards the sides of the trench shall be left to allow for subsidence. The crown of earth, however, should not exceed 10 cms.

Where road bends or lawns have been cut or kerb stones displaced, the same shall be repaired to the satisfaction of the architect and all surplus earth or rock removed to places as specified.

In locations such as road crossing, entry to building in paved areas etc. cables shall be laid in pipes or closed ducts.

All cable entry/ exit points into the building through pipe sleeves shall be properly sealed with water and fire safe sealants in an approved manner to avoid any seepage of water into the building.

Manholes of adequate size, as decided by the Architect, shall be provided to facilitate of adequate strength feeding/ drawing in of cables and to provide working space for persons. Suitable manhole covers with frame of proper design shall cover Manholes.

CABLE LOOPS: Sufficient cable loop length shall be left at both ends.

7. CABLES ON HANGERS OR RACKS/ TRAYS

The contractor shall provide and install all iron hangers racks, or racks with die-cast cleat, with fixing rag bolts or girder clamps or other specialist fixing as required.

Where hangers or racks are to be fixed to wall sides ceiling and other concrete structures, the contractor shall be responsible for cutting away, fixing and grouting in rag bolts and making good the damages as required.

The hangers or racks shall be designed to leave at least 25 mm clearance between the cables and the face to which it fixed. Multiple hangers shall have two or more fixing holes. All cables shall be saddled at not more than 500 mm intervals. These shall be designed to keep provision of some spare capacity for future development. Minimum spacing between the cables shall be one diameter of the cable or as specified.

8. CABLE TRAY

a) The MS cable trays should have undergone rigorous rust proofing process, which should comprise of alkaline, degreasing, descaling in diluted sulpharic acid and a recognized phosphating process. The sheet work shall then be given two coats of oxide primer before two coats of final painting. Cable trays shall be either painted (Stove enameled) or hot dip galvanized as called for in the schedule of quantities.

b) Cable trays shall be complete with bends, joints, coupler plates and accessories as may be required for joining the cable trays.

c) Cable trays shall be either perforated or ladder type as called for in the schedule of quantities.

9. PERFORATED CABLE TRAYS

Standard Technical details of perforated cable tray shall be as follows:

S. No.	SIZE OF TRAY (Width)	THICKNESS & COLLAR HEIGHT
1.	150mm to 450mm width	2mm thick & 50mm collar
2.	600mm to 750mm width	2mm thick & 50mm collar
3.	900mm to 1200mm width	3mm thick & 50mm collar

Note: Supports shall not be charged extra. It shall be considered to be included in the rate of the tray.

10. LADDER TYPE CABLE TRAYS

Standard technical details of ladder type cable trays shall be as follows:

S. No.	SIZE OF TRAY	SIZE OF MAIN CHANNEL OR RUNNER	SIZE OF RUNG & SPACING	CABLE TRAY SUPPORT
1.	900mm to 1500mm	25 x 100 x 25 x 2.5mm	20 x 50 x 20 x 2.5mm @ 250 C/C	50 x 50x 5mm angle @ 1000mm spacing.
2.	450mm to 750mm	20 x 75 x 20 x 2.0mm	20 x 50 x 20 x 2mm @ 250 C/C	40 x 40 x 5mm angle @ 1250mm spacing.
3.	150mm to 300mm	20 x 75 x 20 x 2.0mm	15 x 35 x 15 x 2mm @ 250 C/C	40 x 40 x 3mm angle @ 1500mm spacing.

Hangers shall be minimum 10mm dia GI Round bar.

Fixing/ supporting arrangement shall be as approved by the Consultant/ Owner/ PMC

Hardware to be used in cable tray system shall be galvanized or zinc passivated.

Note: Supports shall not be charged extra. It shall be considered to be included in the rate of the tray. All structural steel shall be according to the latest revision of IS: 226 & 808.

a. Quality of Zinc

Zinc to be used shall conform to minimum Zn 98 grade as per requirement of IS: 209-1992.

b. Coating Requirement

Minimum weight of zinc coating for mild steel flats with thickness upto 6 mm in accordance with IS:6745-1972 shall be 400 g/sqm.

The weight of coating expressed in grams per square meter shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.

The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash and dross inclusions, bare patches black spots, pimples, lumpiness, runs; rust stains bulky white deposits, blisters.

Mild steel flats/ wires shall undergo a process of degreasing, pickling in acid, cold rinsing and then galvanizing.

11. TESTING OF CABLES

The Megger value in normal dry weather shall be 50 mega ohm for 1.1 KV grade cable. Cables shall be tested at works for the following tests before being dispatched to site by the project team:

a. Insulation Resistance Test.
b. Continuity resistance test.
c. Sheathing continuity test.
d. Earth test. (in armoured cables)

e. Hi Pot Test.

Test shall also be conducted at site for insulation between phases and between phase and earth for each length of cable, before and after jointing. On completion of cable laying work, the following tests shall be conducted in the presence of the Owner's site representative:

a. Insulation Resistance Test (Sectional and overall)
b. Continuity resistance test.
c. Sheathing continuity test.
d. Earth test.

All tests shall be carried out in accordance with relevant Standard Code of Practice and Electricity Rules. The Contractor shall provide necessary instruments, equipment and labour for conducting the above tests and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the PMC/ Owner representative.

12. CABLE TAGS

Cable tags shall be made out of 2mm thick aluminum sheets. Each tag shall be 2" in dia or 3" x 3" square with one hole of 2.5mm dia, 6 mm below the periphery, or as approved by Consultant. Cable designations are to be punched with letters/ number punches and the tags are to be tied to cables with piano wires of approve quality & size. Tags shall be tied inside the panels beyond the glanding as well as above the glands at cable entries. Along trays tags are to be tied at all bends. On straight lengths, tags shall be provided at every 5 meters.

Cables shall be secured to cable trays with 3mm thick x 25mm wide aluminum strips/ suitable GI clamp, or as approved by Consultant, at 1000 mm intervals and screwed by means of rust proof screws, washers and bolts, of adequate but not excessive lengths. Cable trays for horizontal runs suspended from the ceiling will be supported with mild steel straps or brackets, at 1000 mm intervals and the overall tray arrangement shall be of a rigid construction. External cabling route marker with GI plate marked with "DANGER 1.1 kV CABLE" with 1 meter long GI angle iron grouting bracket including 1:3:6 ratio cement concrete base block of minimum size 200 x 200 x 350 mm to be provided or as approved by Elect. Supply Company.

SUB-HEAD: I. UPS SYSTEM

1.0 General

1.1 Summary

The units will have state-of-the-art technology with high degree of reliability in operation for continuous operation 24 hrs. and 365 days an year. This specification defines the electrical and mechanical characteristics and requirements for a continuous duty, highly reliable standalone type **true on-line double conversion UPS system using PWM IGBT technology** i.e. the **IGBT** Rectifier of the UPS system converts the input AC power to DC and then the **IGBT** inverter converts the DC into clean AC power. The UPS must use the most advanced Microprocessor technology. The UPS shall provide high quality AC power for sensitive electronic equipment loads. It should also supply clean power automatically without any break in the supply in the absence of raw power. Under no conditions will the protected system get direct supply from the raw mains unless there is fault in the protected system.

System Configuration and operation in normal conditions:

Each modular UPS unit shall be made up of the following components, described in detail in this specification:

- IGBT rectifier
- battery charger
- IGBT inverter
- Isolation Transformer
- battery
- automatic bypass (via a static switch)
- user and communications interface
- battery management system.

Following protections shall be provided with each UPS module:

- Inverter Under & Over voltage protection.
- Inverter over temperature protection.
- Over load current protection.
- Battery under/ over voltage protection.
- Battery end of discharge protection.
- Manual by-pass closed.
- By-pass SCR failure.
- Back feed fault.
- Output short circuit.
- Rectifier input under/ over voltage.
- EPO (Emergency power off)
- Rectifier input
- Over temperature.
- Input single phase/ phase reversal.
- Rectifier input under/ over frequency.
- DC short circuit

Software base control & monitoring on remote PC on LAN shall be provided.

2.0 Modes of Operation

The UPS system shall operate in double-conversion mode as indicated below.

2.1. Normal operation

(normal AC source available)

The rectifier of each modular UPS unit shall supply its inverter and charger. The UPS shall continuously supply the load with backed up electrical energy and the charger shall float charge the battery.

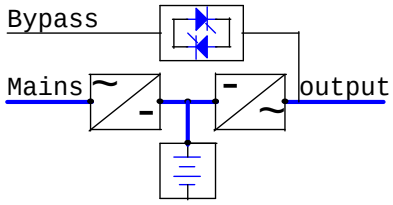


Fig-2 (A)

2.2. Operation on battery power

(normal AC source not available or outside tolerances)

Upon failure or excessive deterioration of the normal AC source, the inverter of UPS unit shall continue to supply the load from battery power without interruption or disturbance, within the limits imposed by the battery backup time.

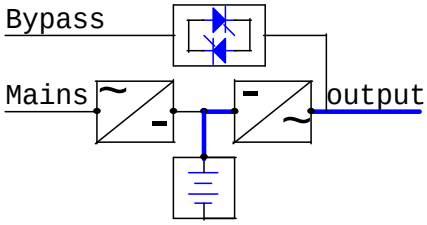


Fig.-2(B)

2.3. Battery recharging

(normal AC source restored)

When the normal AC source is restored, the rectifier of each modular UPS unit shall again power its inverter, without interruption or disturbance to the load, while the charger automatically recharges the battery.

2.4. Transfer to bypass AC source

(☞ system without redundancy)

The system does not provide redundancy. The inverter of the UPS shall supply the load. The automatic bypass of UPS unit shall be connected to the same bypass AC source.

Voluntary shutdown or a major fault on a modular UPS unit shall result in automatic transfer, without interruption, of the load to the bypass AC source via the bypass of each modular UPS unit, including the unit shut down, if the AC bypass is within tolerances and synchronised with the inverter outputs.

On request, the UPS system may automatically transfer the load with a micro-interruption (adjustable from 15 to 1000 ms) if synchronisation with the bypass source has not been established, to enable operation in downgraded mode and enhance supply of power to the load.

In all cases, to ensure load transfer in complete safety, the system shall simultaneously control the

static switch.
Modular UPS units shall continue to supply the load.

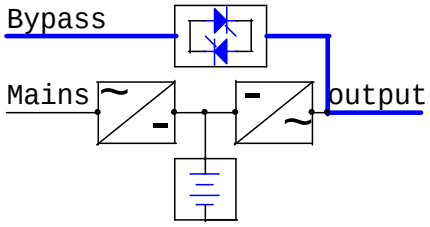


Fig.-2(C)

2.5. UPS-system maintenance

All power and control electronics of the modular UPS units making up the UPS system shall be accessible from the front of the UPS.
For maintenance purposes, the UPS system shall include an external, mechanical, manual bypass system with one-button operation, common to all modular UPS units.
For personnel safety during servicing or testing, this system shall be designed to isolate the UPS system while continuing to supply power to the load from the bypass AC source. The UPS shall also include a device making it possible to isolate the rectifier and the charger of each modular UPS unit from the normal AC source.

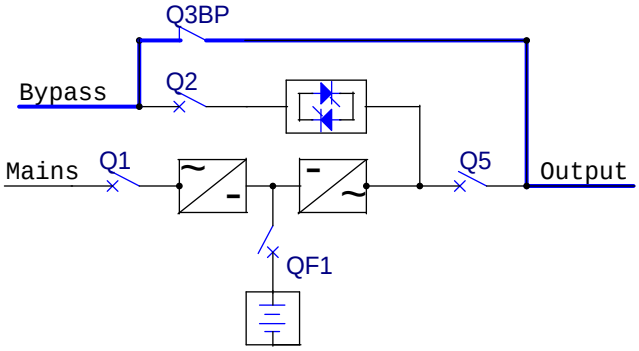


Fig. –2(D)

2.6. Battery maintenance

For safe maintenance, the battery of each modular UPS unit shall include a circuit breaker to isolate the battery from the rectifier, the charger and the inverter. When the battery is isolated from the system, the UPS shall continue to supply the load without interruption or disturbance, except in the event of a normal AC source outage.

2.7. Cold start (normal AC source absent)

The battery of each modular UPS unit shall be capable of starting the UPS if the normal AC source is absent and continue supplying power to the load within the specified backup time. Cold start on battery power shall be possible on the condition that the system shall have started at least once on normal AC power.

3.0 Sizing and general characteristics

3.1. Technology

The UPS system technology shall be based on IGBT transistors for all the power converters (rectifier, charger and inverter with variable chopping frequency).

3.2. Rating

The UPS system shall be sized to continuously supply a load of **------ kVA** at a power factor of 0.8.
The UPS system shall be made up of 1 UPS unit, having a power rating of **------ kVA.**
There shall be **------ KVA** units operating independently, with independent 90 minutes battery backups.

3.3. Battery backup time

The battery backup time in the event of a normal AC source outage shall be 10 minutes, for a load power factor of 0.8 for each UPS.
The battery of each UPS unit shall be designed for a service life of 5 years. It shall be selected and sized correspondingly, for a load power factor of 0.8

3.4. Types of loads accepted

The UPS system shall accept high crest factors (3:1) without derating (kW) to ensure correct operation with computer loads and loads where the leading power factor can reach 0.9.
The total harmonic voltage distortion at UPS output (THDU downstream) shall respect the following limits:
- THDU downstream ph/ph $\leq$ 3% for non-linear loads.

3.5. PFC sinusoidal-current input rectifiers

The UPS system shall not draw a level of harmonic currents that could disturb the upstream AC system, i.e. it shall comply with the stipulations of guide IEC 61000-3-4.
The PFC input rectifiers of the modular UPS units, using sinusoidal-current IGBTs, shall have the following performance levels:
- total harmonic current distortion (THDI) upstream of the rectifier not exceeding 5%
- input power factor (PF) greater than 0.99 from 50% load upwards.

3.6. Outputs without a transformer

To reduce losses, dimensions and weight, the output of each UPS unit shall be of the transformer less type and the neutral shall be recreated electronically.

3.7. Efficiency

Overall efficiency (between the rectifier inputs and the UPS output) shall be greater than or equal to:
- 93% from 50% load to full rated load (In).

Battery Management Function - The UPS has advanced battery management functions including battery fault detection, backup time & remaining life forecast.

Soft Start Function - Complete delay soft start function can reduce the surge to the UPS unit and utility source.

Alarm and Protection Function - The UPS can generate audible and visual alarm through LCD, input/ output contacts and network transmission. It can help maintenance personnel to locate and clear the faults that are sent out in time, accurately and in detail.

Automatic Re-start when Utility returns – On failure of the input mains supply the UPS goes to battery mode. After the batteries are completely discharged the UPS system shuts down. It must automatically restart on the resumption of the input supply.

1.2 SYSTEM DESCRIPTION

1.2.1 Design Requirements - UPS Module

A. Voltage.

Input/ Out voltage specifications of the UPS shall be:
Rectifier Input: (380) (400)(415) volts, three-phase 4-wire-plus-ground.
Bypass Input (if used): (380) (400)(415) volts, three-phase, 4-wire-plus-ground.
Output: 415 volts, 3 phase, 4-wire-plus-ground.

B. Output Load Capacity

Specified output load capacity of the UPS shall be **------ KVA** at 0.8 lagging power factor.

1.2.2 PERFORMANCE REQUIREMENTS

1. AC Input to UPS

A. Voltage Configuration: three-phase, 4-wire plus ground.
B. Voltage: (380)(400)(415) V
C. Voltage Range: +/-15% of nominal.
D. Frequency: Field selectable 50Hz or 60 Hz
E. Frequency: Nominal frequency range +/- 10%
F. Voltage distortion: The harmonic content introduced into the mains supply shall comply with IEC 61000-3-4/ AS2279 Part 2 for harmonic voltage distortion at the Point of Common Coupling (PCC) with other loads. Where higher impedance Mains or Generator supplies are present, the manufacturer shall offer reduced current distortion options to ensure IEC 61000-3-4/ AS2279 Part 2 requirements are complied to when interfaced with the proposed UPS system.
G. Input PF: > 0.99 from 50% to 100% of rated load.
H. Input power Factor at low operating loads of <25% shall not lead to leading power factor at any time.

2. AC Output, UPS Inverter

a) Inverter Shall be IGBT based

b) Voltage: (415)V

c) Voltage Configuration: Three-phase, 4-wire plus ground.

d) Voltage Regulation: ± 1% steady state.

e) Frequency: Field selectable 50 Hz or 60Hz, (+ 0.5 or 2Hz adjustable).

f) Frequency Slew Rate: 1Hz/ sec to 2Hz/ sec adjustable
g) Phase Displacement: ± 1 degree for balanced load.

± 1 degree for 100% unbalanced load.

h) Voltage Distortion: 1% Typical 2% maximum for liner loads

<5% total harmonic distortion (THD) for 100% non-linear loads with 3:1 crest factor.

i) Output Power Rating: Rated kVA at 0.8 lagging power factor.

j) Overload Capability: 110% for 60 minutes
125% for 10 minutes
150% for 30 seconds
200% for 500 milliseconds

k) Voltage Transient Response: ± 2%

l) Transient Recovery Time: to within ±1% of output voltage within 60 milliseconds

m) Voltage Unbalance: Balanced load 1%

100% unbalanced load 2%

n) Inverter Short Circuit Current Limit:
150% full load current for 30 seconds
270% full load current for 150 milliseconds

1.3 ENVIRONMENTAL CONDITION

1.3.1 The UPS shall be able to withstand the following environmental conditions without damage or degradation of operating characteristics:

A. Operating Ambient temperature

UPS Module: 0ºC to 40ºC
Battery: 25 ± 5ºC

B. Storage/ Transport Ambient Temperature

-25ºC to 70ºC

C. Relative Humidity: <90% at 20ºC

D. Altitude Operating: to 1000 meters above mean Sea Level de-rated for higher altitude applications. 1% per 100m between 1000 & 2000

E. Audible Noise

Noise generated by the UPS under any condition or normal operation shall not exceed 65 dbA measured 1.5 meter from surface of the UPS.

1.3.2 Design Requirements - Matching Battery

A. Battery Cells: Sealed, lead-acid, valve-regulated.

B. Reserve Time: minutes at full load, 0.8 power factor, with ambient temperature between 20 and 30ºC.

1.4 UPS Delivery Submittals

Submittal upon UPS delivery shall include:

One instruction manual: Manual shall include a functional description of the equipment with block diagrams, safety precautions, instructions, step-by-step operating procedures and routine maintenance guidelines, including illustrations.

1.5 Quality Assurance

1.5.1 Manufacturer Qualifications

A minimum of five year's experience in the design, manufacture, and testing of solid-state UPS systems is required. Standards ISO90001, CE certified to level A of EN55022.

1.5.2 Factory Testing

Before shipment, the manufacturer shall fully and completely test the system to assure compliance with the specification.

2.0 PRODUCT

2.1 Fabrication

2.1.1 Materials

All materials of the UPS shall be new, of current manufacture, high grade and free from all defects and shall not have been in prior service except as required during factory testing.

2.1.2 Construction and Mounting

The UPS unit, comprised of input isolator, rectifier/ charger, inverter, static transfer switch, maintenance bypass switch, and static bypass input switch should be housed in a freestanding steel enclosure with key-lockable doors. Front access only shall be required for expedient servicing, adjustments, and installation. The enclosure will be built to comply with IP20 when the doors are open. The UPS cabinet shall be cleaned, primed, and painted with the manufacturer's standard color. The UPS shall be constructed of replaceable subassemblies. Printed circuit assemblies shall be plug-in. Like assemblies and like components shall be interchangeable.

2.1.3 Cooling

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.

2.2 Components

2.2.1 Rectifier/Charger

A. General

The term rectifier/ charger shall denote the solid-state equipment and controls necessary to convert incoming AC power to regulated DC power for input to the inverter and for battery charging. The rectifier/ charger shall be 6 Pulse three phase-controlled IGBT based bridge type with constant voltage/ current limiting control circuitry.

B. Input Current Walk-In

The rectifier/ charger shall contain a timed walk-in circuit that causes the unit to gradually assume the load over a 10-second time interval after input voltage is applied.

C. Fuse Failure Protection

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.

D. DC Filter

The rectifier/ charger shall have an output filter to minimize ripple voltage into the battery. Under no conditions shall ripple voltage into the battery exceed 1% RMS. The filter shall be adequate to insure 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.

E. Battery Recharge

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. The charging shall be an automatic cycle per DIN 41772 characteristic I -U (boost to floating charge switching, with current measuring criteria and control during recharge). Both float and recharge voltages shall be adjustable. The charge voltage can also be manually controlled. The use of the inverter is inhibited during manual charging.

2.2.2 Inverter

A. General

The term inverter shall denote the solid-state equipment and 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 **Insulated Gate Bipolar Transistor, phase-controlled, pulse width modulated (PWM)** design capable of proving the specified AC output.

B. Overload Capability

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. Fault Clearing and Current Limit

Without bypass supply available to the inverter shall be capable of supplying an overload current of **150% of its full-load rating in excess of Thirty Seconds**. For greater currents or longer time duration, the inverter shall have electronic greater currents or longer time duration, the inverter shall have electronic current-limiting protection to prevent damage to components. The inverter shall be self-protecting against any magnitude of connected output overload (Vce Trip). Inverter control logic shall sense and disconnect the inverter from the critical AC load without the requirement **to clear protective fuses**.

D. Output Frequency

The output frequency of the inverter shall be controlled by an oscillator. The oscillator shall hold the inverter output frequency to + .01% for steady state and transient conditions.

2.2.3 Display and Controls

A. Monitoring and Control

The UPS shall be provided with a microprocessor based unit status display and controls section designed for convenient and reliable user operation. A system controls section designed for convenient and reliable user operation. A system power flow diagram, a percentage load and battery time remaining display shall be provided as part of the monitoring and controls sections, which depicts a single-line diagram of the UPS. Illuminated visual indicators shall be of the long-life light-emitting diode (LED) type. All of the operator controls and monitors shall be located on the front of the UPS cabinet. The monitoring functions such as metering, and alarms shall be displayed on an alphanumeric LCD display. Additional features of the monitoring system shall include:

Menu-driven display with test format selectable in five (5) languages (English, German, French, Spanish, or Italian).

B. Metering

The following parameters shall be displayed:
Battery voltage
Battery charge/ discharge current
Battery remaining backup time
Input voltage, frequency and current
Output AC voltage line-to-line and line to neutral Output AC current for each phase and neutral and % load used of nominal capacity for each phase.
Output frequency
Output Crest Factor
Output Power Factor
Active Power (kW) Apparent Power (kVA)
Temperature - Ambient, battery

C. Warning and Alarm Messages

Normal Operation Input breaker open
Output breaker open Rect. breaker open
Battery breaker open On Manual bypass
Bypass absent Bypass over limits
Bypass under limits Bypass freq. over limit
Bypass Phase Rotation Bypass SCR fail
Bypass inhibit Local Bypass inhibit remote
Load on bypass on bypass due to over temperature
Rectifier off Local Rect. off remotely
Rectifier Block Rectifier overload
Rectifier over temp Rectifier Fuse fail
Inverter off local. Inverter off remotely
Inverter block Inverter overload
Inverter over temp Inverter out of sync
Inverter overvoltage Inverter under voltage
Inverter fuse fail D.C Volts High
D.C Volts low Inverter no voltage
Inverter Peak Volts low Battery under test
Battery test fail Discharge battery
Battery E.O.D. Boost Charge
DC Bus over volt Battery Low
Battery Fuse Fail Bat. Fast over volt
Bypass overuse Cut-off overload
Cut-off over temp Cut-off emergency stop

Overload Cut-off max overload

Software Warnings
Bad EPROM program Err. LRC param. Pag 1
Err. LRC Param Pag 2 Err. LRC Param Pag 3
Err. LRC Alar Hist Err. LRC Even Hist
Back-up battery low Error LRC table
Error LRC Panel Modem Wrong Config
Modem no response Modem false command
Modem time-out trasm Can bus no response
Autonomy XXXX min

D. Controls

Four pushbuttons shall be located on the operator control panel.
Enter
Escape
Up
Down
The push buttons shall permit the operator either to select options from a menu for display on the LCD winder or to change the value of some parameters. One push-button - alarm silence switch.

E. Power Status Diagram

A mimic panel shall be provided to depict a single line diagram of the UPS.
Indicating lights shall be integrated within the single line diagram to illustrate the status of the UPS. The three LEDs shall indicate the following status.
Bypass voltage OK
Load on bypass
Load on inverter
The % load with respect to the nominal power and the real time remaining battery backup time should be displayed in the LCD display of the UPS.

F. Ethernet Connectivity Interface Port

An Ethernet Connectivity based interface port shall be provided for remote display of UPS status information on a computer terminal (by others).

2.2.4 Static Transfer Switch

A. General

A static transfer switch and bypass circuit shall be provided as an integral part of the UPS. The static switch shall be naturally commutated high-speed static (SCR-type) device rated to conduct full load current continuously to enable the critical load to be connected to the inverter output or bypass power source. The static transfer switch control logic shall contain and automatic transfer control circuit that senses the status of the inverter logic signals, and operating and alarm conditions. This control circuit shall provide an uninterrupted transfer of the load to an alternate bypass source, without exceeding the transient limits specified herein, when an overload or malfunction occurs within the UPS, or for bypassing the UPS for maintenance.

B. Uninterrupted Transfer

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 and automatic transfer of the critical load to the bypass source if any of the following conditions are present:
Inverter/ bypass voltage difference exceeding pre-set limits
Bypass frequency out of limits
Bypass out-of-synchronization range with inverter output.

C. Uninterrupted Retransfer

Retransfer of the critical AC load from the bypass source to the invert 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 if one of the following conditions exists:
Bypass out of synchronization range with inverter output
Inverter/ bypass voltage difference exceeding pre-set limits
Overload condition exists in excess of inverter full load rating
UPS fault condition present.

2.2.5 Maintenance Bypass Isolator

A. General

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

B. Maintenance Capability

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

C. Wall Mounted Battery Circuit Breaker (BCB)

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 in a separate wall mounted enclosure. 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.

D. Split Bypass feature

UPS shall have both a rectifier input and bypass input. Two separate input sources must be provided. An internal bypass circuit breaker shall be provided for connection to the bypass source.

E. BMS connectivity

Each UPS should have Network Interface Card for Modbus BMS & LAN Connectivity simultaneously. RS 485 Port has to be available for BMS interface in the UPS module. RJ 45 connectivity over Ethernet has to be available for LAN Connectivity.

3.0 FIELD ENGINEERING SUPPORT

The UPS manufacturer shall directly employ a national field service network staffed by factory trained field service engineers to provide start up, maintenance and repair of the UPS equipment.

Standards and tests

3.1. Standards

All equipment shall be designed and built in accordance with accepted engineering practice and applicable international standards, in particular the standards listed below.

A. Safety:

- IEC 60950-1/ EN 60950-1
  Information technology equipment - Safety - Part: General requirements
- IEC 62040-1/ EN 62040-1
  Uninterruptible power systems (UPS) - General and safety requirements for UPS.
- IEC 62040-3 / EN 1000-3
  Uninterruptible power systems (UPS) - Method of specifying the test and performance requirements.
- IEC 60439
  Low-voltage switchgear and controlgear assemblies.
- LV directive: 2006/95/EC

B. Harmonics:

- IEC 61000-2-2 / EN 61000-2-2
  Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems.
- IEC 61000-3-2 / EN 61000-3-2
  Limits for harmonic current emissions (equipment input current ≤ 16 A/ph).
- IEC 61000-3-4 / EN 61000-3-4
  Limits for harmonic current emissions (equipment input current > 16 A/ph).
- IEC 61000-3-5 / EN 61000-3-5
  Limitation of voltage fluctuations and flicker.
- EN 50160
  Voltage characteristics of public networks.
- IEEE 519
  Recommended practices and requirements for harmonic control in electrical power systems.

C. EMC:

- EN 50091-2
  UPS - EMC.
- IEC 62040-2/ EN 62040-2
  Uninterruptible power systems (UPS) - Electromagnetic compatibility (EMC) requirements.
- EMC Directive 2004/108/EC
  For equipment liable to cause or be affected by electromagnetic disturbances.

D. Quality:

Design, production and servicing in compliance with standard ISO 9001 - quality organisation.

E. Ecological environment:

Manufacturing in compliance with standard ISO 14001.

F. Acoustic noise

- ISO 3746: Sound power levels.
- ISO 7779/ EN 27779: Measurement of airborne noise emitted by computer and business equipment.

What is more, the equipment shall comply with eco-design and eco-manufacturing criteria in view of sustainable development and to that end, the manufacturer shall be able to demonstrate:

- R&D and production on an ISO 14001 certified site
- Manufacture with over 90% recyclable materials
- Capacity to recover products at the end of their service life and provide proof of destruction by a certified organisation.
- The environmental profile of the product, which shall be supplied with the sales offer.

3.2. Certification of conformity

The manufacturer shall provide, on request, a complete qualification file demonstrating compliance with the above standards. What is more, the indicated levels of performance shall be confirmed by certification from independent laboratories (e.g. TÜV or Veritas).

TECHNICAL SPECIFICATIONS OF UPS SYSTEM

	UPS TOPOLOGY	True on-line double conversion PWM IGBT based.
A	**INPUT**	
1	Input voltage	415V, 3 phase, 4 wires
2	Input voltage tolerance	+10 %, -15%
3	Input frequency	50 Hz
4	Input frequency tolerance	+/- 15 %
5	Input current limit	115% (Adjustable between 100 - 125%)
6	Power walk - in period	30 seconds
	Input THDi	<5% for 25% to 100% load
	Input Pf (from 50% load)	>0.99
7	Input circuit Preferred	IGBT based, PFC bridge rectifier
8	Inbuilt Input & Bypass Isolator	Required, Isolator

B	**OUTPUT**	
1	Module full load rating kVA/ kW	------- KVA
2	Rated voltage	3 phase
3	Rated current	Vendor to specify
4	Phase Voltage asymmetry (For Three Phase output UPS only) a] Balance load b] 100% unbalanced load	 1% 2%
5	Voltage Phase shift (In case of three phase Output UPS) - With balanced load - With Unbalanced load	 120 +/- 1 deg 120 +/- 1 deg
6	Output voltage adjustment range	+/- 5%
7	Phase displacement (In case of three phase Output UPS) a] Balance load b] 100% unbalanced load	 120 deg. +/- 1 deg 120 deg. +/- 1 deg
8	Output power factor range	0.8 or better
9	Internal oscillator stability	+/- 0.1 %
10	Mains synchronization tracking	+/- 1 Hz (settable to +/-2)
11	Max. Rate of change of frequency	1 Hz. Per second
12	Output voltage harmonics a] Linear load b] Non-linear load (Crest factor of 3:1)	 < 2% < 5 %
13	Crest Factor	3: 1
14	Overload rating	110% for 60 minutes 125% for 10 minutes 150% for 30 seconds
15	Overload trip	10 min at 125% reducing to 30 seconds at 150%
16	Inverter Efficiency	> 94%
17	Current limit short	Set at 150% of the output power
18	Transient Response	

	a] 100% load change b) Manual transfer of load from UPS to bypass and vice-versa C] Automatic transfer of load form UPS to bypass	+/- 2% 0 msecs when in sync 0 msecs in sync
19	Transient recovery time	Recovery to +/- 1 % in < 60 msec.
20	Manual Bypass Isolator	One with each UPS Module
21	Confirmed Overall Efficiency of UPS with all Filter Options at	
	100% Load 75% Load 50% Load 25% Load	>94% >94% >93% >92%

C	DC CHARACTERISTICS	
1	Nominal DC bus voltage	408 V to 576 V
2	Battery isolation	Manually closed circuit breaker with under voltage release and over current trip
3	Battery fully discharge voltage	326V
4	Allowable voltage drop in battery cables	3 volts at end of discharge voltage.
5	Battery float voltage	459 V
6	Battery end voltage	340 V
7	DC Bus voltage ripple	< 1 RMS
8	Battery recharge current limit	Amps, Vendor to specify
9	No. Of cells	Vendor to specify

D	**CONTROLS**
1	Charger input Isolator
2	Battery circuit breaker (mounted separately in its own enclosure)
3	Inverter output Isolator
4	Bypass line Isolator
5	Maintenance Bypass Isolator
6	Alarm acknowledge / Reset button
7	Inverter On-Off Pushbutton for Manually switching of the Inverter
8	Emergency off push button
E	**MEASURING INSTRUMENTS**
1	LCD panel for Measuring Input Voltage, output currents and Frequency, Output voltages, Output currents and Frequency, Battery Voltage and Charging/ Discharging current.
2	LCD panel should display status of the Battery capacity and backup Time in minutes.
3	Log of time-stamped events This function shall store in memory and make available, for automatic or manually initiated recall, time-stamped logs of all important status changes, faults and malfunctions, complete with an analysis and display of troubleshooting procedures. It shall be possible to time stamp and store at least 2500 events.
E	**PROTECTIONS**
1	RC surge suppressor.
2	Sustained under voltage on input side
3	Phase loss on input side.
4	Negative sequence on input side

5	Semiconductor fuses in the lines for thyristor
6	Snubber circuit for device dv/ dt protection
7	Charger input current limit
8	HRC fuses for filter capacitors
9	Battery current limit
10	DC over voltage
11	Low battery
12	Semiconductor fuses at inverter output
13	Overload
14	Over temperature for the inverter
15	HRC fuses in the control circuit

F	**INDICATIONS (ALARMS)**
1	Inverter Failure
2	Overload (if load exceeds 100%)
3	Overload shutdown
4	Emergency shutdown
5	Equipment over temperature
6	Maintenance Bypass ON
7	DC over voltage
8	Low battery
9	Battery circuit breaker open
10	Battery on load
11	Mains failure
12	Rectifier Failed or Off
13	Inverter Unsynchronized
14	Load on bypass
15	Output voltage error

G. DC link characteristic with battery back-up (as per BOQ)	
NO. of 2/12V SMF lead acid batteries	Vendor to Specify
AH rating for each UPS	Vendor to Specify rating and no. along with VAH
Model / Make	G & Y/ Panasonic
Float voltage	459 V
Final discharge voltage	340 V
Voltage tolerance	+/- 1 %
DC ripple	< 1 %
Charging current limit	10 %
Battery Isolation	With U/V release type Battery Circuit Breaker

Mechanical Dimensions:

Weight of UPS – Kg	Vendor to specify
Dimension of UPS (L x D x H) in mm	Vendor to specify
Ventilation	Forced air cooled with internal fans
Protection Level: * With enclosure closed * With front doors open	 IP 20 IP 20

Environmental:

Operating temperature	0 – 40 deg. C.
Relative humidity	< 90 % (20 deg. C.)
Altitude	1000 m
Storage temp.	From -25 to + 70 deg. C.

The following shall be filled in all respects by the tenderer for technical evaluation.

S.No	Description	To be filled by Tenderer
1	Name of the Organization	
2	Total years of Experience	
3	Total list of customers	
4	Highest capacity of UPS installed	
5	Capacity of UPS offered for CLIENT	
6	Model no.	
1	**INPUT**	
i	Input voltage	
ii	Input voltage tolerance	
iii	Input frequency	
iv	Input frequency tolerance	
v	Input Power factor at nominal voltage and full load	
vi	Harmonic Filters	
vii	Input current limit	
viii	Power walk - in period	
ix	Input circuit	
2	**OUTPUT**	
i	Module full load rating KVA/ KW	
ii	Rated voltage	
iii	Rated current	
iv	Output voltage adjustment range	
v	Output power factor range	
vi	Internal oscillator stability	
vii	Mains synchronization tracking	
viii	Max. rate of change of frequency	
ix	Output voltage harmonics	
x	a] Linear load	
xi	b] Non-linear load (Crest factor of 3:1)	
xii	Crest Factor	
xiii	Overload rating	
xiv	Overload trip	
xv	Inverter Efficiency	
xvi	Current limit short	
xvii	Transient Response	
xviii	a] 100% load change	
xix	b) Manual transfer of load from UPS to	
xx	by-pass and vice-versa	
xxi	C] Automatic transfer of load form UPS	
xxii	to bypass	
xxiii	Transient recovery time	
3	**DC CHARACTERISTICS**	
i	Nominal DC bus voltage	
ii	Battery isolation	
iii	Battery fully discharge voltage	

S.No	Description	To be filled by Tenderer
iv	Allowable voltage drop in battery cables	
v	Battery float voltage	
vi	Battery end voltage	
vii	DC Bus voltage ripple	
viii	Battery recharge current limit	
ix	No. of cells	
x	Battery sharing cubicle	
4	**H. DC link characteristic for …. min battery run time on full load**	
i	No. of 12V SMF lead acid batteries (or)	
ii	AH rating	
iii	Model/ Make	
iv	Float voltage	
v	Final discharge voltage	
vi	Voltage tolerance	
vii	DC ripple	
viii	Charging current limit	
ix	AH/ Nos.	
x	Battery Isolation	
xi	Battery sharing Cubicle	
xii	Weight of UPS – Kg	
xiii	Dimension of UPS (W x D x H) in mm	
xiv	Ventilation	
xv	Colour (two tone)	
xvi	Protection Level	
xvii	Operating temperature	
xviii	Max. Temp. for 8 hr. day	
xix	Relative humidity	
xx	Altitude	
xxi	Storage temp.	
xxii	Warranty offered on UPS	
xxiii	Warranty offered on Battery bank	
xxiv	Delivery Period	

SUB-HEAD: J. EARTHING

1. SYSTEM OF EARTHING

The system shall be TNS with 4 wires supply system (R, Y, B, N and 2 Nos. E) brought from the main LT Panel.

All non-current carrying metal parts of the electrical installation shall be earthed as per IS: 3043 – 1987 with latest amendment. All metal conduits, cable sheath, switchgear, DB's, light fixture, equipment and all other parts made of metal shall be bonded together and connected to earth electrodes. Earthing shall be in conformity with provisions of rules 32, 61, 62, 67 and 68 of Indian Electricity Rules, 1956.

All earthing conductors shall be of high conductivity copper or GI, as specified in the schedule of quantities & shall have protection against mechanical damage. The cross-sectional area of earth conductors shall not be smaller than half that of the largest current carrying conductor.

Main earthing conductors shall be taken from the earth connections at the main L T panel to an earth electrode with which the connection is to be made. All joints in tapes shall be with four rivets and shall be brazed in case of copper and by welding bolting in case of GI. Wires shall be connected with crimping lugs, all bolts shall have spring washers. Sub- mains earthing conductors shall run from the main distribution panel to the sub distribution panel. Final distribution panel earthing conductors shall run from sub-distribution panel.

Circuit earthing conductor shall run from the exposed metal of equipment and shall be connected to any point on the main earthing conductor, or its distribution panel. Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to distribution panel at which they originate, or otherwise at the commencement of the run by an earthing conductor in effective electrical contact with cable sheathing. Where equipment is connected by flexible cord, all exposed metal parts of the equipment shall be earthed by means of an earthing conductor enclosed with the current carrying conductors within the flexible cord. Switches, accessories, lighting fitting etc. which are rigidly secured in effective electrical contact with a run of metallic conduit shall not be considered as a part of the earthing conductor for earthing purposes, even though the run of metallic conduit is earthed.

a. All Lighting fixtures, sockets outlets, fans, switch boxes and junction boxes etc. shall be earthed with copper wire as specified in schedule of quantities. The earth wire ends shall be connected with solderless/ bottle type copper lugs.

b. All the earth wires in switch boxes, sockets outlets, DB's and light fixtures shall be of green Colour (PVC insulated).

c. Main earth bus shall be taken from the L.T. switch board to earth electrodes. The electrical resistance of earthing conductors shall be low enough to permit passage of fault current necessary to operate fuse or circuit breaker, and it shall not exceed 1 ohm.

2. SIZING OF EARTHING CONDUCTORS

The cross sectional area of earthing conductor shall not be smaller than half of the largest current carrying conductor subject to an upper limit of 80 Sq.mm. If the area of the largest current carrying conductor or bus bar exceeds 160 sq.mm then two or more earthing conductors shall be used in parallel, to provide at least half the cross sectional area of the current carrying conductor or bus bars. All fixtures, outlet boxes, junction boxes and power circuits upto 15 amps shall be earthed with PVC insulated copper wire.

All 3 phase switches and distribution panels upto 60 amps rating shall be earthed with 2 Nos. distinct and independent 4 mm dia copper/ GI wires. All 3 phase switches and distribution panels upto 100 amps rating shall be earthed with 2 Nos. distinct and independent 6 mm dia copper/ GI wires. All switches, bus bar, ducts and distribution panels of rating 200 amps and above shall be earthed with minimum of 2 nos separate and independent 25 mm x 3 mm copper/ GI tape.
Earthing details given in Table – A & B shall be referred to as a general guidance. Exact sizes to be worked out by the contractor as per relevant IS Codes.

TABLE - A

Size of earth leads

(a) For Transformer/Generator Neutral Point Earthing:

Transformer/ DG Set Rating	Electrolytic Bare copper Conductor Wire or strip	Galvanized Iron Conductor wire or strip
50KVA & below/4mm dia	4mm dia	25mm x 6.0mm
75 KVA	25mm x 3.0mm	25mm x 6.0mm
100 KVA	25mm x 6.0mm	32mm x 6.0mm
150 KVA	25mm x 6.0mm	40mm x 6.0mm
200 KVA	25mm x 6.0mm	40mm x 6.0mm
250 KVA	25mm x 6.0mm	40mm x 6.0mm
300 KVA	25mm x 6.0mm	40mm x 6.0mm
500 KVA	40mm x 6.0mm	40mm x 6.0mm
750 KVA	40mm x 6.0mm	50mm x 6.0mm
1000 KVA	40mm x 6.0mm	50mm x 6.0mm
1250 KVA	50mm x 6.0mm	50mm x 6.0mm
1500 KVA	50mm x 6.0mm	75mm x 6.0mm
2000 KVA	50mm x 6.0mm	75mm x 6.0mm

NOTE: - EXACT SIZE OF EARTH LEAD TO BE DETERMINED AS PER LATEST IS CODES.

TABLE – B

(b) For Equipment Earthing (Applicable to Transformer, Generators, Switchgears, Panels, DB's, Motors etc.)

Rating of 400-V, 3ph 50 cy. Equipment In KVA	Bare Electrolytic Copper conductor Wire/ Strip	Galvanised Iron Wire/ Strip
upto 5	2mm dia	2mm dia
6 to 15	3mm dia	3mm dia
16 to 30	4mm dia	4mm dia
31 to 50	6mm dia	6mm dia
51 to 100	25mm x 3.0mm	25mm x 6.0mm
101 to 125	25mm x 3.0mm	32mm x 6.0mm
126 to 150	25mm x 3.0mm	32mm x 6.0mm
151 to 200	25mm x 6.0mm	40mm x 6.0mm
201 to 300	25mm x 6.0mm	50mm x 6.0mm
301 to 500	32mm x 6.0mm	50mm x 6.0mm

501 to 800	40mm x 6.0mm	50mm x 6.0mm
Above 800	50mm x 6.0mm	50mm x 6.0mm

NOTE: EXACT SIZE OF EARTH LEAD TO BE DETERMINED AS PER LATEST IS CODES.
NOTE: ALL THREE PHASE EQUIPMENT SHALL BE DOUBLE EARTHED

3. PROHIBITED CONNECTIONS

Neutral conductor, sprinkler pipes, or pipes conveying gas, water, or inflammable liquid, structural steel work, metallic enclosures, metallic conduits and lighting protection system conductors shall not be used as an earthing conductor.

4. CONNECTION/ JOINTS

The earthing connections/ joints should be bolted, riveted, welded, brazed type.
In case of bolted joints, GI/ Passivated hardware's of adequate size/ nos. should be used for firm connections. The minimum contact area should be equal to the width of the strip or cross-sectional area of earthing lead. Welded/ brazed joints should be smooth and continues. All welded/brazed joints should be treated with anti-corrosive paints to protect it from corrosion/ rusting.

All bolted connections/ joints of Cu strip should be tinned.

Wherever, flexible earthing connection is must, it should be hydraulically crimped lugs of Copper/ Aluminum.

The effective earthing connection surface should be smooth & free from paints and oxide coatings.

5. EARTHING

The following must always be ensured in earthing system:
- All earth pits should be at equi - potential. Main equipotential bonding conductors shall be provided.
- Extraneous conductive parts such as gas pipes, other service pipes and ducting risers and pipes of fire protection equipment and exposed metallic parts of the building structure shall be bonded to earth.
- The Contractor shall get the soil resistivity test done at his own cost of the area where earthing pits are to be located before starting the installation.

6. RESISTANCE TO EARTH
The resistance of earthing system shall not exceed 1 ohm.

SPECIFICATION FOR HOT DIP GALVANIZING PROCESS FOR MILD STEEL USED FOR EARTHING FOR ELECTRICAL INSTALLATION

7. GENERAL REQUIREMENTS

a. **Quality of Zinc**
Zinc to be used shall conform to minimum Zn 98 grade as per requirement of IS: 209-1992.

b. **Coating Requirement**
Minimum weight of zinc coating for mild steel flats with thickness upto 6 mm in accordance with IS:6745-1972 shall be 400 g/sqm.
The weight of coating expressed in grams per square meter shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.

The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash and dross inclusions, bare patches black spots, pimples, lumpiness, runs; rust stains bulky white deposits, blisters.

Mild steel flats/ wires shall undergo a process of degreasing pickling in acid, cold rinsing and then galvanizing. Jointing of earthing tape shall be by welding. All joints and cut ends shall be properly painted with aluminum paint.

8. MAINTENANCE FREE CHEMICAL EARTHING:

Maintenance Free Chemical Earthing shall be done strictly as per manufacturer's recommendations. It shall be completely maintenance free, long life close to 25 years, environmentally safe, non-corrosive & electrically conductive. The earth resistance results shall be less than one ohm.

SUB HEAD K. IP CCTV SURVEILLANCE SYSTEM:

1. INTENT OF SPECIFICATION

a) This specification is intended to cover the following activities and services in respect of IP video surveillance system for Plant Surveillance System with all components and accessories. The Activities are: -

- o Designing of complete system using specification for different equipment and cables.
- o Procurement of all required materials by contractor and organizing pre-dispatch inspection at contractor's place.
- o Providing engineering data, drawings and O&M manuals of all equipment for Owner's records.
- o Packing and transportation from the contractor's place to the site. In case of imported items Customs/ port clearance, if required shall be organized by the contractor.
- o Receipt, unloading, handling, storage, insurance, preservation and conservation of equipment at site. However client may provide space for site office.
- o Pre-assembly fabrication if any, erection, testing, commissioning and putting into satisfactory operation of all the equipment, cabling and complete IP video surveillance system in a planned and systematic manner acceptable to the Owner. This includes the earthing of camera & equipments also. All items required for earthing and erecting work is to be done by vendor.
- o Furnishing of spares on FOR site basis.

b) The bidder shall be responsible for providing all material, equipment and services specified or otherwise which are required to ensure and fulfill the intent of operability, maintainability and the reliability.

c) It is not intended to specify completely herein all aspects of design and construction of equipment; nevertheless, the equipment shall conform in all workmanship and shall be capable of performing in continuous commercial operation in industrial environment round the clock.

d) The equipment offered by the Bidder shall be complete in all respects. Any material and component not specifically stated in this specification shall be deemed to be included unless specifically excluded. All such Equipment/ accessories shall be supplied without any extra cost.

e) Design and manufacturing shall be such that equipment/accessories of same type and ratings are interchangeable.

2. SCOPE OF WORK

The scope of work includes design, manufacture, shop testing, packing and transport to site/ storage before erection, installation, commissioning and testing of the complete system. The details of scope of work are as follows:

a) Preliminary survey of the site and locations of IP cameras and cable route, finalization of same in consultation with engineer-in-charge and submission of detailed time schedule for executing the work.

b) Submission of final drawing as detailed.

c) Design, manufacture and shop testing of all the equipment as per Bill of Material at vendor's place and organizing the pre-dispatch inspection as per quality plan. This includes the NVR application and client software also (original with licenses).

d) Packing, transporting and then storage of the material at site till installation of equipment.

e) Organizing and executing the cable trenching, cable laying, termination/ finalized in the route and erection of GI pole for IP camera at designated locations.
f) Fixing of cameras and junction boxes on the GI pole.
g) Fixing of network switches, media converters at different locations in racks.
h) All interconnections, all IO terminations, all cores of fiber optic cable, power cable, media convertors, access points as per the requirement.
i) Installation of network video recorder (NVR), PCs, keyboards in both control room as per the requirement.
j) Installation, testing and commissioning of the complete system and test run of the same for 15 days.
k) Demonstration of all features of the system to client and commencing the trial run for 15 days after test run.
l) Submission of all test reports, as built drawings, all technical documents, manuals etc.
m) Any supply of item and work to be executed related with successful working of complete system reliability (with all features working) which is not included in the above points has to be informed by the vendor and same has to be supplied/ executed by them at no extra cost.
n) Providing training to client personnel on all aspects of the system, programming and maintenance.
o) Warranty period shall be for a period of 36 months for the entire system from the date of acceptance by client i.e. issue of completion certificate by competent authority. All systems including units, assemblies, and sub assemblies shall be covered under warranty. Any parts found defective during warranty period shall be replaced by the contractor without any charges whatsoever.
p) The contractor should attend all breaks down jobs within 24 hours.

3. BRIEF OVER VIEW OF IP VIDEO SURVEILLANCE SYSTEM:

3.1 It is decided to have main control room at Security department having network video recording system (NVRS) with the required software and data storage facility installed from where apart from cameras control facility, the recording of all cameras output for suitable duration can be done. The control functions of cameras shall be provided at Security department. The cameras shall have the day and night vision capability and should be able to withstand the outdoor industrial environment condition. Simultaneously the monitoring on a 32" Plasma LCD monitor screen of all/selected cameras shall be available with the help of PC if required.

3.2 Surveillance CCTV system is required to ensure effective surveillance of an area as well as create a tamperproof record for post event analysis. The System shall provide an online display of video images on TFT monitors at central control rooms.

3.3 System should facilitate viewing of live and recorded images and controlling of all cameras by the authorized users present in the LAN.

3.4 System should provide inter-operability of hardware, OS, software, networking, reporting, and communication protocols. System expansion should be possible through off-the-shelf available hardware.

3.5 Equipment with better specifications shall be accepted.

4. GENERAL SPECIFICATIONS:

4.1 Proposed IP surveillance system shall be an open standard based integrated system with IP network centric functional and management architecture aimed at providing high-speed manual/ automatic operation for best performance.

4.2 System shall use video signals from various IP cameras installed at different locations, process them for viewing on workstations/ NVR/ monitors at central Control Room and simultaneously record all the cameras after compression using MPEG-4 or better standard. The system shall also have capability and provision to transmit video signals in real time to user defined remote locations. It should also be possible to monitor and control the cameras through an IP network from a remote location.

4.3 The NVR/ CAMERA SERVER can be embedded type or server based. However the NVR/ CAMERA SERVER software shall run on common off the shelf available servers/ NVR (Camera server & Database server). NVR/ Camera Server shall be able to handle 16 or more cameras.

4.4 Network Video Recorder shall offer both video stream management and video stream storage management. Recording frame rate & resolution in respect of individual channel shall be programmable.

4.5 System should ensure that once recorded, the video cannot be altered

4.6 System shall provide sufficient storage of all the camera recordings for a period of 30 days or more @ 25 FPS, at 720p or better quality using necessary compression techniques for all cameras (extended capacity of cameras i.e. present capacity + 25 %).

4.7 System shall use IP enabled cameras. The video shall be compressed using MPEG-4 or better standard and streamed over the IP network.

4.8 The recording resolution and frame rate for each camera shall be user programmable.

4.9 The Area under surveillance shall be monitored and controlled from Central Control Room through NVR and workstations.

4.10 Surveillance System shall operate on 12V DC/ POE/ 230 V, 50 Hz single phase power supply. Power for all the equipment will be conditioned using on-line UPS. If any equipment operates on any voltage other than the supply voltage and supply frequency, necessary conversion/correction device for supply shall be supplied along with the equipment.

4.11 Power supply system to all surveillance cameras shall have provision for receiving back-up power (POE) from an off-site switch in the event of total power cut-off in the complex.

4.12 All the control equipment's e.g. servers, NVR/ CAMERA SERVER etc. shall be provided in standard Racks.

4.13 All the cameras & control equipment, meant for installations, shall be suitable to work from (-) 10 degree C to (+) 50 degree C with RH up to 80% non-condensing. This temperature range may be achieved with or without heater.

5. SYSTEM REQUIREMENTS:

5.1. IP Camera shall be used for image capture. All Cameras shall be Day/Night cameras.

5.2. All cameras shall be powered through UPS. Housing of cameras meant for use must be integrated by the camera manufacturer.

5.3. System must provide built-in facility of watermarking or Digital certificate to ensure tamperproof recording so that these can be used as evidence at a later date, if so desired.

5.4. All camera recordings shall have Camera ID & location/ area of recording as well as date/ time stamp. Camera ID, Location/ Area of recording & date/ time shall be programmable by the system administrator with User ID & Password.

5.5. Facility of camera recording in real-time mode (25 FPS)/15/12.5/10 or lower FPS as well as in any desired combination must be available in the system.

5.6. Facility of Camera recording in CIF, 4 CIF, 720p as well as in any combination i.e. any camera can be recorded in any quality – Selective or Group of cameras must be available in the system.

5.7. System to have facility of additional camera installation beyond the originally planned capacity.

5.8. In order to optimize the memory, while recording, video shall be compressed using MPEG-4 or better standard and streamed over the IP network. Once on the network, video can be viewed on a Control room workstation shall be recorded on NVR/ CAMERA SERVER and shall be backed up on internal storage.

5.9. System shall be triplex i.e. it should provide facility of Viewing, Recording & Replay simultaneously.

5.10. The offered system shall have facility to export the desired portion of clipping (from a desired date/ time to another desired date/ time) on USB flash drives. Viewing of this recording shall be possible on standard PC using standard software.

5.11. Central Control Room will have NVR for Camera operation. For monitoring purposes, Video monitors shall be setup with suitable mounting arrangements, as per user requirements. Facility for viewing and controlling all the cameras at various other locations, as required, shall be provided.

5.12. There shall be a Control System with Video Control Software to manage all the video surveillance devices.

5.13. Video stream from individual cameras shall be recorded on respective NVR/ Camera Server & subsequently archived to internal backup device. System shall have provision to automatically over-write the new information after the period of 30/31 days & necessary script/ algorithm must be available in the Application.

5.14. All the workstations in LAN should be provided with software to view and control the cameras, encoders and retrieve the recorded video images from the NVR/CAMERA SERVER/ NAS/ Raid backup device seamlessly.

5.15. The system should have automatic frame rate detection and recording facility. The system should have automatic (Actively Controlled Frame rate) frame rate recording feature; if the scene is inactive the video can be streamed at a much lower frame rate. As soon as the motion analysis software detects movement the video is streamed at full frame rate.

5.16. NVR shall keep track of all configurations & events. This will help in proper System administration & management etc.

5.17. The system should provide Camera fault and signal loss, etc. It shall facilitate with TFT on screen display to log all type of faults and alert alarms to the operator with date & time.

6. TECHNICAL SPECIFICATIONS OF THE SUB-UNITS:

6.1. **FULL HD NETWORK DOME IR CAMERA WITH VARIFOCAL LENS**

The product specified shall be indoor surveillance dome camera system. The camera system shall consist of an integrated 2 MP high resolution, CMOS camera, integrated IR and vari-focal lens.

Parameter	Description
Scanning System	Progressive
Image Sensor	1/2.8" 2 Megapixel progressive scan CMOS
Effective Pixels	1920 (H) x 1080 (V)
Minimum Illumination	0.01Lux @ F1.4 (Color), 0 Lux @ F1.4 (IR LEDs on)
IR LEDs	850nm, 2 High Power LEDs
IR Illumination Distance	20m depending on scene reflectance, Smart IR
S/N Ratio	More than 50dB
Gain Control	Auto/ Manual
Electronic Shutter Speed	Auto/ Manual, 1/3~1/10000s
Lens Type	2.8 - 12mm , F1.4
Horizontal Angle of View	98.1° - 29.9°
White Balance	Auto/ Manual
Day/Night	Auto (ICR)/ Color / B&W
Backlight Compensation	BLC / HLC / DWDR
Exposure Mode	Manual/ Low noise/ Low motion blur/ Auto Ranges from 1/3 to 1/10000
Noise Reduction	3D DNR
Video Flip	Support mirror function and flip function.
Snapshot	Max 1f/s snapshot. File extension name is JPEG.
Privacy Mask	Supports 4 privacy mask zones (maximum)
Video Setup	Bright, contrast.
Video Information	Channel title, time title, motion detect, privacy mask.
Motion Detection	396 (18 x 22) detection zones; sensitivity level ranges from 0 to 100; area threshold ranges from 0 to 100. Activation event: video storage, image snapshot, log, email function and etc.
Power Supply	12 V DC, or PoE IEEE 802.3af
Power Consumption	4.5 W maximum
Connectors	Ethernet port RJ-45 10/100Base-T; 12 V DC
Operational Temperature	-30°C to +60°C
Relative Humidity	Less than or equal to 95%
Impact Rating	IK10
Video Compression	H.264/ MJPEG
Primary Stream Resolution	1080p (1920x1080)/ 1.3M (1280×960)/ 720P (1280×720) / D1 (704×576 / 704×480) / CIF (352×288 / 352×240)
Frame Rate	Primary Stream: 1080p/ 1.3M / 720p / D1 @ 1~25/30 fps Secondary Stream: D1/ CIF @ 1~25/30 fps
Video Streaming	Dual streaming: H.264/ MJPEG
Video Bit Rate	H.264: 1280 ~ 8192Kbps @ 1080p
Security	Up to 20 users, multiple user access levels with password protection
Supported Protocols	IPv4/IPv6, HTTP, HTTPS, SSL, TCP/IP, UDP, UPnP, ICMP, IGMP, SNMP, RTSP, RTP, SMTP, NTP, DHCP, DNS, PPPOE, DDNS, FTP, IP Filter, QoS, Bonjour

Smart Phone	IOS, Android
Standards	ONVIF Profile S
Emissions	FCC Part 15B, CE (EN 55022)
Immunity	EN 50130-4
Safety	EN 60950-1 UL/CSA 60950-1

6.2. **FULL HD NETWORK DOME IR CAMERA WITH FIXED LENS**

The product specified shall be indoor surveillance dome camera system. The camera system shall consist of an integrated 2 MP high resolution, CMOS camera, integrated IR and fixed lens.

Parameter	**Description**
Image Sensor	1/3" Megapixel progressive scan CMOS
Effective Pixels	1920 (H) x 1080 (V)
Minimum Illumination	0. 5 Lux @ F1.6 (Color); 0 Lux @ F1.6
Number of IR LEDs	27
IR Beam Distance	Max. 20m
S/N Ratio	More than 50db
Gain Control	Auto / Manual
Electronic Shutter Speed	Auto/Manual (1/3~1/100000s)
Lens Type	3.6 mm Fixed, F1.6
Horizontal Angle of View	88°
Mount Type	Board-in type
White Balance	Auto / Day / Night / Customized
Day/Night	Auto (ICR) / Color / B&W
Backlight Compensation	BLC / DWDR
Exposure Mode	Manual / Low noise / Low motion blur / Auto Ranges from 1/3 to 1/10000
Noise Reduction	3D Noise Reduction
Video Flip	Mirror function and flip function
Snapshot	Maximum 1 snapshot, saved as JPEG
Privacy Mask	4 zones
Video Setup	Brightness and contrast
Video Information	Channel title; time title; motion detection; privacy mask
Motion Detection	96 (18 x 22) detection zones; Sensitivity level ranges from 0 to 120; area threshold ranges from 0 to 120. Activation event: video storage; image snapshot; log; email function
Watermark	Support
Video Compression	H.264 / MJPEG
Primary Stream Resolution	1080p (1920 x 1080) / SXGA (1280 x 1024) / 1.3M (1280 x 960) / 720p (1280 x 720) / D1 (704 x 576 / 704 x 480) / CIF (352 x 288 / 352 x 240)
Frame Rate	Main Stream: 1080p / SXGA / 1.3M / 720p / D1 @25/30fps Sub Stream: D1 / CIF@25/30 fps
Video Bit Rate	1280K ~ 8192 Kbps @ 1080p
Security	Up to 20 users, multiple user access levels with password protection

Web Browser	Microsoft Internet Explorer 6.0 or later; Mozilla Firefox®; Google Chrome; and Apple Safari
Supported Protocols	IPv4/IPv6, HTTP, HTTPS, SSL, TCP/IP, UDP, UPnP, ICMP, IGMP, SNMP, RTSP, RTP, SMTP, NTP, DHCP, DNS, PPPOE, DDNS, FTP, IP Filter, QoS, Bonjour
Smartphone Compatibility	iOS (iPhone® and iPad), Android
Standards	ONVIF Profile S
Default Restoration	Built-in reset button
Power Supply	12 V DC PoE IEEE 802.3af, Type 1, Class 3
Power Consumption	Max. 6W
Construction	Housing: Die-cast aluminum and polycarbonate Color: White
Recording and Storage	Network storage
Connectors	1-channel wire Ethernet port; 10/100 Base-T Ethernet
Operational Temperature	-20°C to +60°C
Working Humidity	≤ 95%
Emissions	FCC Part 15B, CE (EN 55022)
Immunity	EN-50130-4
Safety	UL/CSA 60950-1

6.3. **JUNCTION BOX:**

Junction box shall accommodate all the equipment required at the camera site. It shall withstand the high temperature environment. The provision for mounting the JB on the pole shall be made available in the junction box. It shall be vandal proof and weather proof so as to withstand the industrial environment and climate. The JB shall have a switch to switch the power supply from UPS. It shall accommodate the FO converter and other components of the system. All the equipment except the cameras shall be accommodated in the junction box, which is to be mounted on same pole. For terminating all cables the junction box should have suitable terminating block or connections. All the cables shall be clamped with suitable clamp to avoid the damage of the core/ conductors due to cables weight. Each junction box should be grounded to earth with suitable copper cable and earth pit made near the pole location. The earth pit making, earthing material required including the grounding wire shall be in scope of contractor. The earth pit shall be made as per the standard procedure being followed in GCF. The junction box shall be of IP 65 standards or better and vandal proof.

6.8 NETWORK VIDEO RECORDER:

6.8.1 NVR & SOFTWARE

6.8.1.1 HARDWARE SPECIFICATIONS

ITEM	**DESCRIPTION**
Operating System	LINUX/Windows
Processor	High performance Dual-core embedded microprocessor
Video Input	32 channel @D1/ 16 channel @720P/ 8 channel @1080P/4 channel @ 3MP
Compatible Protocol	Support ONVIF
Video Output	1HDMI(1920x1080,1280x1024), 1VGA(1920x1080,1280x1024), 1BNC (800x600)
Video Standard	PAL or NTSC

Compression	H.264 / MJPEG
Video Recording	32channels@D1/4CIF
Multi-screen Channels	1 and 4 Channels
Audio Input	The audio input with video. It requires that IPC supports audio input.
Motion Detection	It requires that IP Camera and Encoder support motion detection.
Alarm Event	Recording, Alarm, Buzzer and Screen tips
Alarm Input	16 alarm inputs for local, network alarm from IP camera
Alarm Output	4 outputs
Internal HDD	8 SATA ports, 32TB storage supported
Backup	Flash drive, USB HDD, Network download
HDD Management	HDD faulty alarm
Recording Mode	Manual, Schedule, Video Event trigger(Motion detection) ,Panic and Alarm trigger
Search Mode	Date/Time, Event (Alarm, Motion detection), codec type search (accurate to second),Log link
Playback	4 Channel simultaneous playback (forward / reverse, fast playback, slow playback, pause, full screen, backup selection)
Digital Zoom	Digital zoom in live view and playback
Protocol Support	HTTP,HTTPS, TCP/IP, RTSP,RTP/RTCP,UDP,NTP,DHCP,IPC search
Remote Client Control Function	Monitor, PTZ control, Playback, Configuration, File download, Log information, Alarm collect, Firmware Upgrade
Concurrent User	Min 20, accessible over web, IOS, Android Mobile devices.
Network Interface	2 RJ-45 port (10/100M/1000M) with Load Balancing Feature
USB Interface	3 USB2.0 ports
Serial Interface	1 RS-232
PTZ Control Interface	1 RS-485
Power Input	100~240 VAC 50~60Hz
Power Consumption	< 50W (without HDD)
Operating Temperature	-10°C ~ 55°C
Relative Humidity	20% to 80%
Dimensions	Standard 2U height,
Web Client	Required
Instant Playback	Required
Water Marking/Digital Signature	Required
Certification	CE, FCC, CCC, MA

6.8.1.1 SOFTWARE SPECIFICATIONS

The NVR Application Software need to be installed in NVR as embedded for managing and monitoring the all the IP cameras in the network for hassle free operation. The software make should be same as that of the camera make.

6.8.1.1.1 Main Features:

1 The NVR shall deliver 16-channel real-time recording at 720p resolution 25 FPS. The NVR must have 1080P HDMI video output, VGA output and BNC output.
2 The NVR shall support multicast for remote users.
3 Management shall be flexible. The NVR can either be used as standalone devices or perform as part of a larger system. When used independently, the NVR shall be interfaced with IP cameras via ONVIF to quickly and conveniently construct a high-definition IP surveillance system at multiple sites.
4 The NVR shall also be seamlessly integrated with smart IP security platform from same OEM. Operators can easily perform recording, live viewing, playback, configuration, PTZ control, video switch, and so forth.
5 The NVR shall support CMS software
6 NVR shall have below system performance as minimum;
- Support log system.
- Intelligent recording and alarm linkage upon the triggering of events
- Remote network camera set-up and image adjustment
- Automatic IP search and "one-click" IP camera import.
- Support Patrol live view.
- Support HDD hot swap.
- Support 8 SATA HDDs up to 32TB, 3 USB2.0
- Support ONVIF
- Support the IP cameras form same OEM
- Integration with security & surveillance management system from same OEM
- Support Web client Remote control.
- Support VMS viewer from VMS OEM.
- Support Dual Network
- 16 channel display on one single monitor
- Digital Water Mark
- Instant Playback
- Alarm trigger E-mail
- Defog & EIS
- Support Both IOS & Android App access

6.8.1.2 Client Workstation for CMS

CPU	Intel® Core™ i3 / i5 2.66 GHz or latest
Memory	4GB / 8 GB or as required
Optical Drive	DVD-RW
HDD	1TB or as required
Graphics Adapter	NVIDIA® 9200 or above, 1GB independent graphic card
OS	Windows 10 Professional 64-bit

6.9 NETWORK COMPONENTS:

6.9.1.1 Layer-2 8 / 16 / 24 port switch

6.9.1.2 MEDIA CONVERTER:

- Single mode Fx to Tx convertor (The individual media convertors are required at camera end)
- Shall support a data rate of 100 Mbps copper to Fiber single mode upto a distance 1000 meters.
- The converter at camera end should be mountable on junction box and at switch and should be rack mountable.
- Auto negotiation
- Half and Full duplex operations
- Electrical port RJ45

- Optical Port – SC
- Shall be supplied along with the power supply.

6.9.1.3 Media Convertor housing chassis - At switch end the media converter should be housed in chassis as there will be more than one converter. The chassis should be able to house minimum of 8 media converter cords and should have in built AC to DC power supply.

6.9.1.4 Layer-3 Switches

Number of ports	24 Nos single mode 1000 base. Fiber LX duplex port module (16 ports) (to converge Fibre cable from Encode L2 Switches and existing Lan) 12 Nos 10/100/1000 base TX RJ 45 port to connect to L2 switch uplink and NVR box
Transmission Method	Store and forward
MAC Address Table	16 K entries per device
Packet Buffer Memory	16 Mbytes per device
Power Supply	AC 230 V @ 50 Hz

6.9.1.5 POWER CABLE: Armoured:

No. Of cores	3
Voltage	1100 V
Conductor	Annealed Bare Copper
Conductor diameter	2.5 sq. mm
Conductor resistance	7.4 Ohm / KM
No. of strands	7
Diameter of strands	0.68 mm
Insulation	PVC
Insulation thickness	0.8mm
Colour	RED, BLACK, GREEN
Inner Sheath thickness	0.3mm FRLS PVC
Outer sheath thickness	1.5mm
Insulation resistance	100M ohm / KM @500V DC
Armouring	GI
Armouring thickness	1.4mm
No. Of wires	20
Metering	Input voltage, Battery voltage, Output voltage, Balance battery autonomy, Output frequency and load power (%)
By Pass :	
Voltage tolerance	10% adjustable
Transfer time	Instantaneous
PC interface Communication	RS 232
User Interface	Should be through means of a front panel consisting of LCD display and LED's for various functions

7 The Camera Erection - The camera dome should be mounted on top of the pole in such a way that the dome bottom surface is parallel to the ground surface. The top hole of pole should be aligned to cable entry points of camera dome. It is desired that camera erection to be done only in the end just before testing. The power and UTP cable from camera to junction box shall be done as per requirement.

8 **Testing -** The testing of the equipment and complete system shall commence only after erection of all equipment and completion of all cabling and earthing work. First the testing of all section of cabling and individual equipment shall be done and then only integrated testing shall commence.

a. **Testing of Cameras -** After mounting the camera output shall be checked individually at junction box termination with the help of LCD TV/Laptop for clear visual output. The control junction shall be checked only in integrated mode.

b. Testing of all other equipment like server, storage, video monitors, network video recorder shall be done in integrated testing mode.

c. After completion of individual testing as mentioned above of different equipment and cable section all connections and connectorisation shall be done for integrated testing.

d. In integrated testing following shall be observed:

- Video output of each camera on monitor of control room PCs.
- The working on Network Video Recorder system.
- The working of CMS software and demonstration of all its features to client.
- The working of Recording storage and demonstration of all its features.
- Searching of video history of particular camera.

e. If any component, cable segment, software feature is not found working same shall be made functional by replacement / repair of that equipment / software.

f. After completion of integrated testing and successful completion of it the test run shall be commenced which will last for 15 days in continuous operation round the clock. In the test run all important parameters shall be monitored and tabulated at regular interval and jointly signed by client and contractor representative. During the test run the complete system availability should be 100% including that of individual camera output. If the system availability is less than 100% for 15 days then the exercise shall be extended till we get 100% availability for continuous 15 days. Here availability means clear output from individual camera with PTZ control from control room monitor and functioning of Network Video Recorder system with all its functions.

g. After completion of test run the trial run will start for 15 days during which the performance of system shall be monitored. Although performance data shall not be tabulated during this period but availability of all Cameras, Network Video Recorder, Client Software on terminals of client LAN should be 100%. In case these components are not available 100% then trial run shall be extended till availability of 100% is achieved for continuous 15 days. After this the system shall be accepted by client.

h. After completion of trial run, the warranty period shall start which will be 36 months from date of completion of trial run and system acceptance by client.

11. OTHER REQUIREMENTS: TECHNICAL MANUALS/ DOCUMENTATION:

All manuals and documents shall be in English language and in such a way that a qualified engineer/ technician is able to fully understand and do the preventive as well as break down maintenance with the help of these manuals.

The contractor at the time of installation shall provide TWO complete sets of the following documents conforming to the proposed system: -

a. Detailed specifications.
b. Block diagram of the systems with brief descriptions.
c. Schematic circuit diagram as also unit/ module wise diagram and stage-by-stage detailed description. The complete wiring details are also to be provided by the vendor.
d. Data flow chart with data at different points during operations & testing.
e. Component layout & position chart/ photograph for ease of locating the components.
f. Servicing/Maintenance Instructions including preventive maintenance schedule. Indicate type of test equipment to be used for maintenance.
g. Trouble shooting chart with proper test sequence, voltage and data at various test points.
h. Detailed operation and technical manuals of all equipment and the system programming details.
i. Original Licenses for all supplied software.

12. TRAINING TO THE CLIENT PERSONNEL:

1. On job training at site on all aspects of operation, programming and maintenance shall be provided by the contractor or his authorized representative to the concerned client officials / users for a period of at least 5 days during the warranty period.

2. Cost of all training has to be borne by the vendor.

3. Vendor has to agree for imparting the training as mentioned above and non-compliance of same by the vendor shall be liable for rejection of the vendor's bid.

13. WARRANTY PERIOD: The contractor shall guarantee that the system including units, assemblies, and sub-assemblies shall be free from any defects due to the defective material, bad workmanship and that the system shall not be less than the guaranteed values.
The guarantee shall be valid for a period of 36 months for the entire system from the date of successful completion of trial run and the system acceptance by client.

SUBHEAD: L **BUILDING MANAGEMENT SYSTEM**

PART 1 GENERAL

1.1 **SUMMARY**

A. Furnish all labor, materials, equipment, and service necessary for a complete and operating Building Management System (BMS), utilizing Direct Digital Controls as shown on the drawings, as in attached Input/Output Summary and as described herein. Drawings are diagrammatic only.

B. All labor, material, equipment and software not specifically referred to herein or on the plans, that is required to meet the functional intent of this specification, shall be provided without additional cost to the Client.

C. Client shall be the named license holder of all software associated with any and all incremental work on the project(s).

1.2 **SYSTEM DESCRIPTION**

A. The entire Building Management System (BMS) shall be comprised of a network of interoperable, stand-alone digital controllers communicating via BACnet MSTP or BACnet over IP communication protocols to a Network Area Controller (NAC) / Router. Building Management System products shall be manufactured as per Lon Works products must be approved in writing by the consulting Engineer and be submitted for approval ten (10) days prior to the date of the bid submittal.

B. The entire Integrated Control and Monitor Management System (IBMS) shall be comprise of a network of interoperable, stand-alone digital controllers communicating on an open protocol communication network to a host computer within the facility (when specified) and communicating via the Internet to a host computer in a remote location. The IBMS shall communicate to third party systems such as Chillers, Boilers, Air-Handling Systems, Energy metering systems, Lighting Management System & other energy management systems, Fire-Life safety systems and other building management related devices with open, interoperable communication capabilities.

C. The IBMS framework shall utilize JAVA based automation products and services with built-in Internet connectivity to a broad range of distribution partners in the building automation, energy services, power/utility, and industrial sectors. The Framework shall bring together the computerization of control applications under the umbrella of single integrated system architecture. The suite of component software applications shall support true plug-and-play, multi-vendor interoperability, resulting in lower automation and information infrastructure costs. The Network Area Controllers (NAC's) shall run a JAVA Virtual Machine (JVM) platform and use a common set of tools for accessing and integrating multiple protocols.

D. The Building Management System (BMS) shall be comprised of Network Area Controller or Controllers (NAC) / Routers. The NAC / Router shall connect to the local or wide area network, depending on configuration. Access to the system, either locally in each building, or remotely from a central site or sites, shall be accomplished through standard Web browsers, via the Internet and/or local area network. Each NAC shall communicate to BACnet Direct Digital Controllers (DDC) and other open protocol systems/devices. The cost of any such user license shall be included in the pricing.

E. The following software packages shall be loaded into the system as minimum standard :-

a. Complete system operational software
b. Site specific data manipulation software
c. Active graphics software
d. Energy management system software
e. Alarm indication software
g. Data Visualization Package
h. Internet Enabled Remote Monitoring Package.
i. Trend viewing and Report management software.

1.3 **SUBMITTAL**

A. Eight copies of shop drawings of the components and devices for the entire control system shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers catalog data sheets and installation instructions for all controllers, valves, dampers, sensors, routers, etc. Shop drawings shall also contain complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings. A complete written Sequence of Operation shall also be included with the submittal package. BMS contractors supplying products and systems, as part of their packages shall provide catalog data sheets, wiring diagrams and point lists to other contractors for proper coordination of work.

B. Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media and protocol. BMS contractors shall provide these diagrams for their portions of work; the Systems Integrator shall be responsible for integrating those diagrams into the overall trunk cable schematic diagrams for the entire Wide Area Network (WAN).

C. Submittal shall also include a complete point list of all points to be connected to the BMS.

D. Upon completion of the work, provide a complete set of 'as-built' drawings and application software on compact disk. Drawings shall be provided as AutoCAD™ compatible files. Eight copies of the 'as-built' drawings shall be provided in addition to the documents on compact disk. BMS contractors shall provide as-built for their portions of work. The BMS contractor shall be responsible for as-built pertaining to overall BMS architecture and network diagrams. All as-built drawings shall also be installed into the BMS server in a dedicated directory.

1.4 **SPECIFICATION NOMENCLATURE**

A. Acronyms used in this specification are as follows:

FMCS	Facility Management and Control System
BMS	Building Management System
NAC	Network Area Controller
DDC	Direct Digital Controller
IBC	Interoperable BACnet Controller
GUI	Graphical User Interface
WBI	Web Browser Interface
PMI	Power Measurement Interface
LAN	Local Area Network
WAN	Wide Area Network
OOT	Object Oriented Technology

PICS Product Interoperability Compliance Statement

1.5 **DIVISION OF WORK**

A. The BMS contractor shall be responsible for all controllers (DDC), control devices, control panels, controller programming, controller programming software, controller input/output and power wiring and controller network wiring.

B. The BMS contractor shall also be responsible for the Network Area Controller(s) (NAC), software and programming of the NAC, graphical user interface software (GUI), development of all graphical screens, Web browser pages, setup of schedules, logs and alarms, BACnet network management and connection of the NAC to the local or wide area network.

1.6 **AGENCY AND CODE APPROVALS**

A. All products of the BMS shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided with the submittal package. Systems or products not currently offering the following approvals are not acceptable.

1. UL-916; Energy Management Systems
2. C-UL listed to Canadian Standards Association C22.2 No. 205-M1983 “signal Equipment”
3. CE
4. FCC, Part 15, Subpart J, Class A Computing Devices

1.7 **SOFTWARE LICENSE AGREEMENT**

A. The CLIENT shall agree to the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

B. The CLIENT shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, CLIENT shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, BMS Server(s), and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the owner. The owner shall determine which organizations to be named in the SI organization ID (“orgid”) of all software licenses. Owner shall be free to direct the modification of the “orgid” in any software license, regardless of supplier.

1.8 **DELIVERY, STORAGE AND HANDLING**

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

1.9 **JOB CONDITIONS**

A. Cooperation with Other Contractors: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It shall be this Contractor's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers, and structural and architectural features.

PART 2 MATERIALS

2.1 **GENERAL**

A. The Building Management System (BMS) shall be comprised of a network of interoperable, stand-alone digital controllers, a computer system, graphical user interface software, printers, network devices, valves, dampers, sensors, and other devices as specified herein. All systems and software within BMS shall be Year 2000 compliant and shall be supported by compliance documentation from the manufacturer.

B. The installed system shall provide secure password access to all features, functions and data contained in the overall BMS.

2.2 **OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES**

A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet, technology, MODBUS, OPC, and other open and proprietary communication protocols in one open, interoperable system.

B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135-2001, BACnet to assure interoperability between all system components is required. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet (BACnet Ethernet/IP,) and/or RS-485 (BACnet MSTP) as specified.

C. All components and controllers supplied under this Division shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.

D. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.

E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.

1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.

2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.3 **NETWORKS**

A. The Local Area Network (LAN) shall be a 100 Megabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, and SOAP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local server.

B. Local area network minimum physical and media access requirements:

1. Ethernet; IEEE standard 802.3
2. Cable; 100 Base-T, UTP-8 wire, category 5
3. Minimum throughput; 100 Mbps.

2.4 NETWORK ACCESS

A. Remote Access.

1. For Local Area Network installations, provide access to the LAN from a remote location, via the Internet. The CLIENT shall provide a connection to the Internet to enable this access via high speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or via the customer's Intranet to a corporate server providing access to an Internet Service Provider (ISP). Customer agrees to pay monthly access charges for connection and ISP.

2.5 NETWORK AREA CONTROLLER (NAC) / ROUTER

A. The BMS contractor shall supply one or more Network Area Controllers (NAC) / Router as part of this contract. Number of area controllers required is dependent on the type and quantity of devices provided in IO Summary.

B. The Network Area Controller (NAC) / Router shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC / Router. It shall be capable of executing application control programs to provide:

1. Calendar functions
2. Scheduling
3. Trending
4. Alarm monitoring and routing
5. Time synchronization
6. Integration of BACnet controller data, Modbus & M-Bus data.

C. The Network Area Controller must provide the following hardware features as a minimum:

1. Two Ethernet Port – 10/100 Mbps
2. One RS-232 port
3. One RS-485 ports
4. Battery Backup
5. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
6. The NAC / Router must be capable of operation over a temperature range of 32 to 122°F
7. The NAC / Router must be capable of withstanding storage temperatures of between 0 and 158°F

8. The NAC / Router must be capable of operation over a humidity range of 5 to 95% RH, non-condensing

D. The NAC / Router shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the NAC / Router shall be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write data stored within it.

E. The NAC / Router shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 32 simultaneous users.

F. Event Alarm Notification and actions

1. The NAC / Router shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
2. The NAC / Router shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.
3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
   a. To alarm
   b. Return to normal
   c. To fault
4. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: Electricals, HVAC, Fire, etc.
5. Provide timed (schedule) routing of alarms by class, object, group, or node.
6. Provide alarm generation from binary object “runtime” and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

G. Control equipment and network failures shall be treated as alarms and annunciated.

H. Alarms shall be annunciated in any of the following manners as defined by the user:

1. Screen message text
2. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
   a. Day of week
   b. Time of day
   c. Recipient
3. Pagers via paging services that initiate a page on receipt of email message
4. Graphic with flashing alarm object(s)
5. Printed message, routed directly to a dedicated alarm printer

I. The following shall be recorded by the NAC / Router for each alarm (at a minimum):

1. Time and date
2. Location (building, floor, zone, office number, etc.)
3. Equipment (air handler #, accessway, etc.)

4. Acknowledge time, date, and user who issued acknowledgement.
5. Number of occurrences since last acknowledgement.

J. Alarm actions may be initiated by user defined programmable objects created for that purpose.

K. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.

L. A log of all alarms shall be maintained by the NAC / Router and/or a server (if configured in the system) and shall be available for review by the user.

M. Provide a "query" feature to allow review of specific alarms by user defined parameters.

N. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

O. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

2.6 DATA COLLECTION AND STORAGE

A. The NAC / Router shall have the ability to collect data for any property of any object and store this data for future use.

B. The data collection shall be performed by log objects, resident in the NAC / Router that shall have, at a minimum, the following configurable properties:

1. Designating the log as interval or deviation.
2. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
3. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
4. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
5. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

C. All log data shall be stored in a relational database in the NAC / Router and the data shall be accessed from a server (if the system is so configured) or a standard Web browser.

D. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.

E. All log data shall be available to the user in the following data formats:

1. HTML
2. XML
3. Plain Text
4. Comma or tab separated values

F. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.

G. The NAC / Router shall have the ability to archive its log data either locally (to itself), or remotely to a server or other NAC / Router on the network. Provide the ability to configure the following archiving properties, at a minimum:

1. Archive on time of day
2. Archive on user-defined number of data stores in the log (buffer size)
3. Archive when log has reached it's user-defined capacity of data stores
4. Provide ability to clear logs once archived]

2.7 **AUDIT LOG**

A. Provide and maintain an Audit Log that tracks all activities performed on the NAC / Router. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NAC / Router), to another NAC / Router on the network, or to a server. For each log entry, provide the following data:

1. Time and date
2. User ID
3. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

2.8 DATABASE BACKUP AND STORAGE

A. The NAC / Router shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.

B. Copies of the current database and, at the most recently saved database shall be stored in the NAC / Router. The age of the most recently saved database is dependent on the user-defined database save interval.

C. The NAC / Router database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

2.9 **DIRECT DIGITAL CONTROLLERS (DDC)**

A. DDC Controllers shall be suitable and rated for operation on RAW Power Supply.

B. Direct Digital Controllers shall be 32 bit microprocessor based Interoperable Bacnet Controllers.

C. The controller shall be capable of either integrating with other devices or stand-alone operation.

D. The controller shall have two microprocessors. The Host processor contains on-chip FLASH program memory, FLASH information memory, and RAM to run the main application. The second processor for BACnet® network communications.

- FLASH Memory Capacity: 372 Kilobytes with 8 Kilobytes for application program.
- FLASH Memory settings retained for ten years.
- RAM: 8 Kilobytes

E. The controller shall have an internal time clock with the ability to automatically revert from a master time clock on failure.

- Operating Range: 24 hour, 365 day, multi-year calendar including day of week and configuration for automatic day-light savings time adjustment to occur on configured start and stop dates.
- Accuracy: ±1 minute per month at 77° F (25° C).

- Power Failure Backup: 24 hours at 32° to 100° F (0° to 38° C), 22 hours at 100° to 122° F (38° to 50° C).

F. The controller shall have an internal DC power supply to power external sensors.
   - Power Output: 20 VDC ±10% at 75 mA.

G. The controller shall have a visual indication (LED) of the status of the device:
   - Controller operating normally.
   - Controller in process of download.
   - Controller is in reflash mode
   - No power to controller, low voltage, or controller damage.
   - Processor and/or controller are not operating.

H. The controller shall have a visual indication (LED) of the BACnet MS/TP communication status of the device:

I. Processor missing bootloader image.
   - Bootloader running and no MS/TP token present.
   - Bootloader running and there is MS/TP communication.
   - BACnet communications processor is not running

J. The minimum controller Environmental ratings
   - Operating Temperature Ambient Rating: -40° to 150° F (-40° to 65.5° C).
   - Storage Temperature Ambient Rating: -40° to 150° F (-40° to 65.5° C).
   - Relative Humidity: 5% to 95% non-condensing.

K. The controller shall have the additional approval requirements, listings, and approvals:
   - UL/cUL (E87741) listed under UL916 (Standard for Open Energy Management Equipment) with plenum rating.
   - BACnet Application Specific Controller (B-ASC)
   - CSA (LR95329-3) Listed
   - Meets FCC Part 15, Subpart B, Class B (radiated emissions) requirements.
   - Meets Canadian standard C108.8 (radiated emissions).
   - Conforms to the following requirements per European Consortium standards:
     EN 61000-6-1; 2001 (EU Immunity)
     EN 61000-6-3; 2001 (EU Emissions)

L. The controller housing shall be UL plenum rated mounting to either a panel or DIN rail (standard EN50022; 7.5mm x 35mm).

M. The controller shall have sufficient on-board inputs and outputs to support the application.
   - Analog outputs (AO) shall be capable of being configured to support 0-10 V, 2-10 V or 4-20 mA devices.
   - Triac outputs shall be capable of switching 30 Volts at 500 mA.
   - Input and Output wiring terminal strips shall be removable from the controller without disconnecting wiring. Input and Output wiring terminals shall be designated with color coded labels.

- Universal inputs shall be capable of being configured as binary inputs, resistive inputs, voltage inputs (0-10 VDC), or current inputs (4-20 mA).
- Relay outputs, where applicable, shall be capable of switching 30 Volts at 1 Amp.

N. The controller shall have three analog outputs (AO).

O. Analog outputs (AO) shall be capable of being configured as digital outputs (DO).

P. The controller platform shall have standard HVAC application programs that are modifiable to support both the traditional and specialized "sequence of operations".

Q. **DDC Panels shall be Free Standing or wall mounting type, powder coated 1.6mm thick CRCA sheet metal, RAL 7035 and lockable. And IP55 rated enclosure.**

2.10 GRAPHICAL USER INTERFACE SOFTWARE

A. **Operating System**:

1. The GUI shall run on Microsoft Windows 7.

B. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.

C. Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:

1. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the GUI shall support the use of scanned pictures.
2. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
3. Graphics shall support layering and each graphic object shall be configurable for assignment to a layer. A minimum of six layers shall be supported.
4. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
   a. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
   b. Holidays shall be set by using a graphical calendar without requiring any keyboard entry from the operator.
5. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
6. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No entry of text shall be required.

D. System Configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:

a. Create, delete or modify control strategies.

b. Add/delete objects to the system.

c. Tune control loops through the adjustment of control loop parameters.

d. Enable or disable control strategies.

e. Generate hard copy records or control strategies on a printer.

f. Select points to be alarmable and define the alarm state.

g. Select points to be trended over a period of time and initiate the recording of values automatically.

E. On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.

F. Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.

G. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.

H. Programming software shall be same as GUI. The Same GUI can be used to configure the DDCs & NAC.

I. Alarm Console

1. The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.

2. When the Alarm Console is enabled, a separate alarm notification window will super cede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

2.11 WEB BROWSER CLIENTS

A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™ or Netscape Navigator™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.

B. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of

processor speed, memory, etc., in order to allow the Web browser to function with the FMCS, shall not be acceptable.

C. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

D. The Web browser client shall support at a minimum, the following functions:

1. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.

2. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.

3. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.

4. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.

5. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.

6. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:

a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.

1. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.

2. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

b. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.

c. View logs and charts

d. View and acknowledge alarms

e. Setup and execute SQL queries on log and archive information

7. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.

8. **Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.**

2.12 SERVER FUNCTIONS AND HARDWARE

A. A central server shall be provided. The server shall support all Network Area Controllers (NAC) / Router connected to the customer's network whether local or remote.

B. Local connections shall be via an Ethernet LAN. Remote connections can be via ISDN, ADSL, T1 or dial-up connection.

C. It shall be possible to provide access to all Network Area Controllers via a single connection to the server. In this configuration, each Network Area Controller can be accessed from a remote Graphical User Interface (GUI) or from a standard Web browser (WBI) by connecting to the server.

D. The server shall provide the following functions, at a minimum:

1. Global Data Access: The server shall provide complete access to distributed data defined anywhere in the system.

2. Distributed Control: The server shall provide the ability to execute global control strategies based on control and data objects in any NAC / Router in the network, local or remote.

3. **The server shall include a master clock service for its subsystems and provide time synchronization for all Network Area Controllers (NAC) / Routers.**

4. The server shall accept time synchronization messages from trusted precision Atomic Clock Internet sites and update its master clock based on this data.

5. The server shall provide scheduling for all Network Area Controllers and their underlying field control devices.

6. The server shall provide demand limiting that operates across all Network Area Controllers. The server must be capable of multiple demand programs for sites with multiple meters and or multiple sources of energy. Each demand program shall be capable of supporting separate demand shed lists for effective demand control.

7. The server shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of all commands issued to Network Area Controllers / Routers. Systems not employing this prioritization shall not be accepted.

8. Each Network Area Controller / Router supported by the server shall have the ability to archive its log data, alarm data and database to the server, automatically. Archiving options shall be user-defined including archive time and archive frequency.

9. The server shall provide central alarm management for all Network Area Controllers / Routers supported by the server. Alarm management shall include:

1. Routing of alarms to display, printer, email and pagers
2. View and acknowledge alarms
3. Query alarm logs based on user-defined parameters

10. The server shall provide central management of log data for all Network Area Controllers / Routers supported by the server. Log data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall include:

1. Viewing and printing log data
2. Exporting log data to other software applications
3. Query log data based on user-defined parameters

E. Server Hardware Requirements: The server hardware platform shall have the following requirements:

1. The computer shall be an Intel Pentium M based computer (minimum processing speed of 2.4 GHz with 1 GB RAM and a 100-gigabyte minimum hard drive). It shall include a DVD-ROM/CD-RW Combination Drive, 2-parallel ports, 2-asynchronous serial ports and 2-USB ports. A minimum 22" flat panel color monitor, 1280 x 1024 optimal preset resolution, 25 ms response time shall also be included.
2. The server operating system shall be Microsoft Windows XP Professional. Include Microsoft Internet Explorer 6.0 or later.
3. Connection to the BMS network shall be via an Ethernet network interface card, 100 Mbps.
4. A system printer shall be provided. Printer shall be laser type with a minimum 600 x 600-dpi resolution and rated for 60-PPM print speed minimum.
5. For dedicated alarm printing, provide a dot matrix printer, either 80 or 132 column width. The printer shall have a parallel port interface.

2.13 SYSTEM PROGRAMMING

A. The Graphical User Interface software (GUI) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GUI shall be through password access as assigned by the system administrator.

B. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.

C. Programming Methods

1. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.
2. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set

values to inputs and monitor the logic for diagnosing execution before it is applied to the system.

4. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.

5. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.14 LonWorks NETWORK MANAGEMENT

A. The Graphical User Interface software (GUI) shall provide a complete set of integrated LonWorks network management tools for working with LonWorks networks. These tools shall manage a database for all LonWorks devices by type and revision, and shall provide a software mechanism for identifying each device on the network. These tools shall also be capable of defining network data connections between LonWorks devices, known as "binding". Systems requiring the use of third party LonWorks network management tools shall not be accepted.

B. Network management shall include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.

C. The network configuration tool shall also provide diagnostics to identify devices on the network, to reset devices, and to view health and status counters within devices.

D. These tools shall provide the ability to "learn" an existing LonWorks network, regardless of what network management tool(s) were used to install the existing network, so that existing LonWorks devices and newly added devices are part of a single network management database.

E. The network management database shall be resident in the Network Area Controller (NAC) / Router, ensuring that anyone with proper authorization has access to the network management database at all times. Systems employing network management databases that are not resident, at all times, within the control system, shall not be accepted.

2.15 **OBJECT LIBRARIES**

A. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.

B. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.

C. In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.

D. All control objects shall conform to the control objects specified in the BACnet specification.

E. The library shall include applications or objects for the following functions, at a minimum:

1. Scheduling Object. The schedule must conform to the schedule object as defined in the BACnet specification, providing 7-day plus holiday & temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphical sliders to speed creation and selection of on-off events.

2. Calendar Object. The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special

event data entry. Data entry to be by graphical "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.

3. Duty Cycling Object. Provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects may be created to control equipment at varying intervals

4. Temperature Override Object. Provide a temperature override object that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling etc.) to maintain occupant comfort or for equipment freeze protection.

5. Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start / stop time object properties based on the previous day's performance.

6. Demand Limiting Object. Provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment set points to effect the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the set point, a message shall be displayed on the users screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.

F. The library shall include control objects for the following functions. All control objects shall conform to the objects as specified in the BACnet specification.

1. Analog Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.

2. Analog Output Object - Minimum requirement is to comply with the BACnet standard for data sharing.

3. Binary Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment run-time by counting the amount of time the hardware input is in an "on" condition. The user must be able to specify either input condition as the "on" condition.

4. Binary Output Object - Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as interstart delay must be provided. The BACnet Command Prioritization priority scheme shall be incorporated to allow multiple control applications to execute commands

on this object with the highest priority command being invoked. Provide sixteen levels of priority as a minimum. Systems not employing the BACnet method of contention resolution shall not be acceptable.

5. PID Control Loop Object - Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable as well as to be disabled to allow proportional control only, or proportional with integral control, as well as proportional, integral and derivative control.
6. Comparison Object - Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.
7. Math Object - Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.
8. Custom Programming Objects - Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including math and logic functions, string manipulation, and e-mail as a minimum. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for re-use.
9. Interlock Object - Provide an interlock object that provides a means of coordination of objects within a piece of equipment such as an Air Handler or other similar types of equipment. An example is to link the return fan to the supply fan such that when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming thereby eliminating nuisance alarms during the off period.
10. Temperature Override Object - Provide an object whose purpose is to provide the capability of overriding a binary output to an “On” state in the event a user specified high or low limit value is exceeded. This object is to be linked to the desired binary output object as well as to an analog object for temperature monitoring, to cause the override to be enabled. This object will execute a Start command at the Temperature Override level of start/stop command priority unless changed by the user.
11. Composite Object - Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering, or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the “contained” application that are represented on the graphical shell of this container.

G. The object library shall include objects to support the integration of devices connected to the Network Area Controller (NAC) / Router. At a minimum, provide the following as part of the standard library included with the programming software:

1. LonMark/LonWorks devices. These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering. Provide LonMark manufacturer-specific objects to facilitate simple integration of these devices. All network variables defined in the LonMark profile shall be supported. Information (type and function) regarding

network variables not defined in the LonMark profile shall be provided by the device manufacturer.

2. For devices not conforming to the LonMark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file, resource file and documentation for the device to facilitate device integration.
3. For BACnet devices, provide the following objects at a minimum:
   - **a.** Analog In
   - **b.** Analog Out
   - **c.** Analog Value
   - **d.** Binary
   - **e.** Binary In
   - **f.** Binary Out
   - **g.** Binary Value
   - **h.** Multi-State In
   - **i.** Multi-State Out
   - **j.** Multi-State Value
   - **k.** Schedule Export
   - **l.** Calendar Export
   - **m.** Trend Export
   - **n.** Device
4. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.
5. For BACnet devices, provide the following support at a minimum
   - **a.** Segmentation
   - **b.** Segmented Request
   - **c.** Segmented Response
   - **d.** Application Services
   - **e.** Read Property
   - **f.** Read Property Multiple
   - **g.** Write Property
   - **h.** Write Property Multiple
   - **i.** Confirmed Event Notification
   - **j.** Unconfirmed Event Notification
   - **k.** Acknowledge Alarm
   - **l.** Get Alarm Summary
   - **m.** Who-has
   - **n.** I-have
   - **o.** Who-is
   - **p.** I-am
   - **q.** Subscribe COV
   - **r.** Confirmed COV notification
   - **s.** Unconfirmed COV notification

t. Media Types
u. Ethernet
v. BACnet IP Annex J
w. MSTP
x. BACnet Broadcast Management Device (BBMD) function
y. Routing

2.16 DDE DEVICE INTEGRATION

A. The Network Area Controller / Router shall support the integration of device data via Dynamic Data Exchange (DDE), over the Ethernet Network. The Network Area Controller shall act as a DDE client to another software application that functions as a DDE server.

B. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of these devices into the BMS. Objects provided shall include at a minimum:

1. DDE Generic AI Object
2. DDE Generic AO Object
3. DDE Generic BO Object
4. DDE Generic BI Object

2.17 MODBUS SYSTEM INTEGRATION

A. The Network Area Controller / Router shall support the integration of device data from Modbus RTU, Ascii, or TCP control system devices. The connection to the Modbus system shall be via an RS-232, RS485, or Ethernet IP as required by the device.

B. **Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of the Modbus system data into the BMS. Objects provided shall include at a minimum:**

1. Read/Write Modbus AI Registers
2. Read/Write Modbus AO Registers
3. Read/Write Modbus BI Registers
4. Read/Write Modbus BO Registers

C. All scheduling, alarming, logging and global supervisory control functions, of the Modbus system devices, shall be performed by the Network Area Controller.

D. The BMS supplier shall provide a Modbus system communications driver. The equipment system vendor that provided the equipment utilizing Modbus shall provide documentation of the system's Modbus interface and shall provide factory support at no charge during system commissioning

2.18 OPC SYSTEM INTEGRATION

A. The Network Area Controller / Router shall act as an OPC client and shall support the integration of device data from OPC servers. The connection to the OPC server shall be Ethernet IP as required by the device. The OPC client shall support third party OPC servers compatible with the Data Access 1.0 and 2.0 specifications.

B. **Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of the OPC system data into the BMS. Objects provided shall include at a minimum:**

1. Read/Write OPC AI Object
2. Read/Write OPC AO Object
3. Read/Write OPC BI Object
4. Read/Write OPC BO Object
5. Read/Write OPC Date/Time Input Object
6. Read/Write OPC Date/Time Output Object
7. Read/Write OPC String Input Object
8. Read/Write OPC String Output Object

C. All scheduling, alarming, logging and global supervisory control functions, of the OPC system devices, shall be performed by the Network Area Controller / Router.

D. The BMS supplier shall provide an OPC client communications driver. The equipment system vendor that provided the equipment utilizing OPC shall provide documentation of the system's OPC server interface and shall provide factory support at no charge during system commissioning.

2.19 **GRAPHICAL USER INTERFACE COMPUTER HARDWARE (DESKTOP)**

A. The browser workstation shall be an Intel Pentium based computer (minimum processing speed of 2.4 Ghz with 1.0 GB RAM and a 100-gigabyte minimum hard drive). It shall include a DVD-ROM/CD-RW Combination Drive, 2-parallel ports, 2-asynchronous serial ports and 2-USB ports. A minimum 17"flat panel color monitor, 1280 x 1024 optimal preset resolution, 25 ms response time, shall also be included.

B. Connection to the BMS network shall be via an Ethernet network interface card, 10 Mbps.

C. A system printer shall be provided. Printer shall be laser type with a minimum 600 x 600-dpi resolution and rated for 8 PPM print speed minimum.

OTHER CONTROL SYSTEM HARDWARE

FIELD DEVICES

1.1 **ELECTRIC AND ELECTRONIC CONTROLS RELATED EQUIPMENT**

General Requirements

All controls shall be capable of operating in ambient conditions varying between 0-55 deg. C and 90% R.H. non-condensing.

All Control devices shall have a 20 mm conduit knockout. Alternatively, they shall be supplied with adaptors for 20 mm conduit.

Ancillary Items

When items of equipment are installed in the situations listed below, the BAS contractor shall include the following ancillary items :

(i) Weather Protection

All devices required to be weatherproofed are detailed in the Schedule of Quantities. IP ratings for the equipment is mentioned in the respective section.

(ii) Pipework Immersion

Corrosion resisting pockets of a length suitable for the complete active length of the device, screwed ½" (13mm) or ¾" (20 mm) NPT suitable for the temperature, pressure and medium.

(iii) Duct Mounting (Metal or Builders Work)

Mounting flanges, clamping bushes, couplings, locknuts, gaskets, brackets, sealing glands and any special fittings necessitated by the device.

Additional features

(i) Concealed Adjustment: All two position switching devices shall have concealed adjustment unless detailed otherwise in the Schedule of Quantities.

(ii) Operating Voltage : All two position switching devices shall operate on 230 v a.c and all accessible live parts shall be shrouded. An earth terminal shall be provided.

GENERAL POINTS:

All Field Instruments / Sensors to have the following:

A. Should be CE/UL Certified
B. Should have individual serial numbers with calibration and traceability certificates
C. Should have option of site calibration and validation
D. Should be of the same make to ease installation, commissioning and post handover services.
E. Should have manufacturers' sales and service office in India mandatorily.

1.2 Temperature Sensors:

A. General:

1. General Requirements:

a. Sensors and transmitters shall be UL / CE listed, provided, as outlined in the input/output summary and sequence of operations.

b. The temperature sensor shall be of the resistance type, and shall be either two-wire 100 ohm platinum RTD, or two-wire 1000 ohm platinum RTD.

c. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

d. The sensor should be calibrateable and rerangeable by COML **protocol on site.**

Point Type	**Accuracy**
Chilled Water	± 0.2°C.
Room Temp	± 0.2°C.
Duct Temperature	± 0.2°C.
All Others	± 0.2°C.

B. Duct Temperature Sensors:

1. Duct sensors shall be rigid or averaging as shown. For Rigid Sensors, length shall be 6". Averaging sensors shall be a minimum of 2m [6 feet] in length.
2. Ambient temperature rating of -30 to +80 deg. C, protection class IP65 and Pt 1000 sensing element with SS316 stem.

For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used. This type of sensor shall be used in all mixing chambers.

C. Immersion Temperature Sensors:

1. Immersion sensors shall be provided with a separable stainless steel well with ½" NPT (M) connection and length shall be 6". Pressure rating of well is to be consistent with the system pressure in which it is to be installed.
2. Thermowell should be single piece Barstock Construction
3. Operating range shall be -20 to 80 deg C; pressure rating shall be min. PN 16, IP 65 protection, 1000 ohms platinum at 0 deg. C. Accuracy to ±0.2°C at 0°C, DIN Class A

D. Outside Air Temperature Sensors:

1. Outside Air sensors shall be rigid sensors with 2" length.
2. Ambient temperature rating of 80 deg. C, protection class IP66 and Pt 1000 sensing element.

For outdoor applications, a weatherproof mounting box with weatherproof cover of Die Cast Aluminium with Stainless Steel protection shield and Viton gasket shall be used.

E. Room Temperature Sensor

1. Outside Air sensors shall be rigid sensors with fire retardant ABS enclosure with internal sensor.

2. Ambient temperature rating of 80 deg.C, protection class IP54 and Pt 1000 sensing element.

1.3 Temperature Transmitters:

1. Sensors and transmitters shall be UL / CE listed, provided, as outlined in the input/output summary and sequence of operations.
2. The temperature sensor shall be of the resistance type, and shall be two-wire 4 – 20mA and 0 – 10 V Jumper settable.
3. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:
4. The sensor should be calibrateable and rerangeable by **COML** protocol on site

Point Type	**Accuracy**
Chilled Water	± 0.1°C.
Room Temp	± 0.1°C.
Duct Temperature	± 0.1°C.
All Others	± 0.1°C.

1.4 Humidity Sensors:

1. Duct and room sensors shall be UL / CE listed have a sensing range of 0% to 100% (at 25 Deg.C) with accuracy of ±2% R.H and ±0.5 Deg.C. Humidity Sensor Element should be All-Polymer sensing element and NTC for Temperature. The RH sensors should incorporat the True RH technology. With fire retardant enclosure.
2. Duct sensors shall be provided with a protection cap with Stainless Steel sintered mesh. Duct probe material should be stainless steel.
3. Outdoor air humidity sensors shall have a sensing range of 0% to 100% R.H. It shall be suitable for ambient conditions of -40°C to 85°C with IP66 protection class.
4. Humidity sensor's drift shall not exceed 0.5% of full scale per year.
5. The sensor should be calibrateable and rerangeable by **COML** protocol on site

1.5 Static Pressure Transmitters for water:

1. Sensor shall be UL / CE listed and have linear output signal. Zero and span shall be field-adjustable.
2. Sensor sensing elements shall withstand continuous operating conditions plus or minus 50% greater than calibrated span without damage.
3. Water pressure sensor shall have SS316 diaphragm construction with SS316 body, proof pressure of 2X and burst pressure of 5X Minimum. Sensor shall be complete with 4-20 mA output, with over voltage protection. The accuracy shall be ±0.25% or better. The total error band shall be ±0.5% or better, IP protection should be IP66.
4. Pressure Transmitter's drift shall not exceed 0.1% of full scale per year.
5. Electric Connector for the same shall be DIN or mini DIN Connector.
6. Internal Snubber to protect from Vibration.
7. The sensor should be calibrateable and rerangeable by **COML** protocol on site

1.6 Differential Pressure Transmitters for water:

1. Sensor shall be UL / CE listed and have linear output signal. Zero and span shall be field-adjustable.

2. Water pressure sensor shall have SS316 diaphragm construction and SS316 body Static Pressure 5X. Sensing elements shall withstand continuous operating conditions of 150psi and static pressure of 1000 psi. Sensor shall be complete with 4-20 mA output, with over voltage protection. The accuracy shall be ±0.25% or better. The total error band shall be ±0.5% or better, with inbuilt local indicator.
3. Pressure Transmitter's drift shall not exceed 0.1% of full scale per year
4. Electric Connector for the same shall be DIN or mini DIN Connector.
5. The sensor should be calibrateable and rerangeable by **COMl** protocol on site

1.7 Differential Pressure Switch for water:

1. Switch shall be UL / CE listed and have field adjustable set point with Snap action microswitch (SPDT).
2. Switch should be able to withstand static pressure of 12 bar and temperature of 100°C. The repeatability should be ±2% or better. Contact rating for the switch shall be 15A 220VAC.
3. The enclosure should have IP54 Protection with option of Direct and Panel Mounting.
4. The sensor should be calibrateable and rerangeable by **COMl** protocol on site

1.8 Differential Pressure Transmitters for air:

1. Transmitter should be UL / CE listed and have a removable LCD display with multiple units. The response time, units and range should be site adjustable through DIP switch to counter adjust fluctuating readings
2. Air pressure sensor shall have Silicone diaphragm construction. Sensing elements shall withstand continuous operating conditions of 1000 Pa and static pressure of 10000 Pa. Sensor shall be complete with 4-20 mA and output, with over voltage protection. The accuracy shall be ±0.5% or better. The total error band shall be ±1% or better.
3. Sensor shall be complete with 4-20 mA and 0 -10 V output simultaneously, with over voltage protection. Transmitter should be available with optional MODBUS output.
4. Sensor shall have linear output signal. Zero and span shall be field-adjustable with 5 Point onsite custom calibration.
5. The sensor should be calibrateable and rerangeable by **COMl** protocol on site

1.9 Multipoint Pitot tube for Air velocity measurement:

1. Pitot Tube should be UL / CE listed and have a MOC of Aluminium Alloy.
2. Should have elliptical shape. Dimensions: 7.8 X 19.5 mm
3. Should have seating gasket for leak proof protection.

1.10 Differential Pressure Switch for air:

1. Switch shall be UL / CE listed and have field adjustable set point with Snap action microswitch (SPDT) with silver / gold plated contacts.
2. Switch should be able to withstand static pressure of 15000 Pa and temperature of 85°C. The repeatability should be ±2% or better. Contact rating for the switch shall be 1A 250VAC
3. The enclosure should have IP65 Protection with option of Direct and Panel Mounting.
4. Set of accessories should be given along with switch.

1.11 Flow Switch for Water:

1. Flow-proving switches shall be UL / CE listed and be paddle type with multiple changeable paddles of SS304 (1" – 6").
2. Paddle type switches (water service only) shall be UL / CE listed, SPDT snap-acting with pilot duty rating (250 VA minimum). Adjustable sensitivity with IP54 Type enclosure. Pressure rating: 1.5MPa, fluid temperature: -25 to 110 deg.C

1.12 Flow Switch for Air

1. Flow-proving switches shall be UL / CE listed and be paddle type with fixed paddle of 6".
2. Paddle type switches (water service only) shall be UL / CE listed, SPDT snap-acting with pilot duty rating (250 VA minimum). Adjustable sensitivity with IP65 Type enclosure. Pressure rating: 1.5MPa, Air temperature: -25 to 100 deg.C

1.13 Chilled Water Flow Meters

1. Sensors shall be UL / CE listed. Flow meter shall be a single electro-magnetic type inline flow meter able to work in conductivities above 5µS.
2. The wetted material shall be constructed of stainless steel with PTFE Lining and electrode material shall be Titanium with Die cast aluminium IP67 Enclosure and LCD Display. Display should indicate Instantaneous, Totalized flow and multiple units.
3. Range shall be field settable.
4. Flow meter accuracy shall not exceed +/- 0.5% with velocities from 3 to 30 fps.
5. Provide output via 4 – 20mA Signal and MODBUS.
6. The sensor should be calibrateable and rerangeable by **COML** protocol on site

1.13B Bi-directional Flow Meters

1. Sensors shall be UL / CE listed. Flow meter shall be a dual sensor type ultrasonic flow meter able to work in conductivities less than 5µS.
2. The sensor shall be constructed of stainless steel with PTFE Lining with Die cast aluminium IP67 Enclosure and LCD Display. Display should indicate Instantaneous, Totalized flow and multiple units.
3. Range shall be field settable with password protection.
4. Flow meter accuracy shall not exceed +/- 0.5% with velocities from 3 to 30 fps.
5. Provide output via 4 – 20mA Signal and MODBUS simultaneously.
6. The flowmeter should have a turn down ratio of 100:1
7. Possibility of having two different flow rates in either direction, due to the process and design conditions, and both flows need to be measured.
8. The sensor should be calibrateable and rerangeable by COML protocol on site
9. Standard of acceptance: Omicron series S301B or approved equal.

1.14 Carbon Monoxide Transmitters:

1. Room sensors shall be UL / CE listed. Carbon Monoxide Transmitter should be wall mounted with 0 – 100 – 200 - 300PPM jumper settable Range.
2. Typical area coverage should be greater than 750 m2
3. Warmup time should be less than 30 seconds
4. The output should be field selectable between 4 – 20mA and 2 – 10VDC and optional MODBUS with Optional Removable LCD and LED light for power indication.
5. The accuracy for the transmitter should be ±3% of F.S with ±1% Drift / year.
6. The transmitter should be able to operate from -10°C to 50°C with fire retardant ABS enclosure.
7. The sensor should be calibrateable and rerangeable by **COML** protocol on site

1.15 Carbon Dioxide Transmitters:

1. Sensors shall be UL / CE listed. Carbon Dioxide Transmitter should be wall mounted with 0 – 10000 PPM Range. The working range of the transmitter should be 2000 – 5000 – 10000 PPM jumper settable. .
2. Typical area coverage should be greater than 700 m^2
3. Warmup time should be less than 30 seconds

4. The internal NDIR CO2 sensor should be replaceable.
5. The output should be field selectable between 4 – 20mA,0 – 20 mA , 0 – 10 VDC ,2 – 10VDC,and MODBUS with Optional Removable LCD and LED light for power indication.
6. The accuracy for the transmitter should be ± 3% of F.S with ±1% Drift / year.
7. The transmitter should be able to operate from -20°C to 80°C with fire retardant ABS enclosure.
8. The sensor should be calibrateable and rerangeable by **COML** protocol on site

1.16 Indoor Air Quality Transmitter:

1. The IAQ Transmitter should be able to display RH, Temperature and VOC Concentrations.
2. The range shall be 0 – 1000 PPM (In reference with 10% H_2)
3. The instrument should have LCD Display.
4. The accuracy for the instrument should be ± 5% of F.S
5. Should be complete with 4 – 20 mA,0 – 5 V,0 -10 V jumper settable with MODBUS
6. The transmitter should be configurable for daisy chain wiring with MODBUS protocol, should be site addressable.
7. The instrument should be able to operate from -20°C to 80°C with fire retardant ABS enclosure.
8. Sensors shall be UL / CE listed.
9. The sensor should be calibrateable and rerangeable by **COML** protocol on site

1.17 Hydrogen Transmitters (LEL Transmitter):

1. Sensors shall be UL / CE listed. Hydrogen Transmitter should be wall mounted with 0 – 100% LEL Range.
2. Typical area coverage should be greater than 300 m^2
3. Warmup time should be less than 30 seconds
4. The output should be 4 – 20mA with 2 Relays for switching option and optional MODBUS output.
5. Transmitter should have a digital LED display.
6. Can be programmed using remote control from 10 meters in line of site distance. Non-intrusive programming for Flameproof model using magnetic pen.
7. The accuracy for the transmitter should be ±1% of F.S with ±0.5% Drift / year.
8. The transmitter should be able to operate from -10°C to 50°C.
9. The enclosure should be explosion-proof, certified by CCOE / equivalent government body.
10. The sensor should be calibrateable and rerangeable by **COML** protocol on site

1.18 OEL Transmitters:

1. Sensors shall be UL / CE listed. OEL Transmitter should be wall mounted with 0 – 100% OEL Range as per the detection media.
2. Typical area coverage should be greater than 300 m^2
3. Warmup time should be less than 30 seconds
4. The output should be 4 – 20mA with 2 Relays for switching option and optional MODBUS output.
5. Transmitter should have a digital LED display.
6. Can be programmed using remote control from 10 meters in line of site distance. Non-intrusive programming for Flameproof model using magnetic pen.
7. The accuracy for the transmitter should be ±1% of F.S with ±0.5% Drift / year.
8. The transmitter should be able to operate from -10°C to 50°C.
9. The enclosure should be explosion-proof, certified by CCOE / equivalent government body.
10. The sensor should be calibrateable and rerangeable by **COML** protocol on site

1.19 Mechanical Pressure Gauges:

1. Pressure Gauges should be UL / CE listed. Should be 100mm dial with Glycerine filling in the guage.
2. It should be bottom mounted with SS316L Socket, Bourdon and Movement. The case shall be SS304 /

SS316 with IP67 protection class.
3. Serial no/tag nos should be engraved on the gauge.
4. The accuracy of the gauges should be ±0.5% of F.S with individual test certificates.
5. Standard of acceptance: Omicron series PGSS or approved equal.

1.20 Mechanical Temperature Gauges:

1. Temperature Gauges should be UL/CE listed. Should be 100mm dial and of Mercury filled type.
2. It should be bottom mounted with SS316L Wetted parts. The case shall be SS304 / SS316 with IP67 Protection class.
3. The accuracy of the gauges should be ±0.5% of F.S with individual test certificates.
4. The stem length should be 6" with SS316 barstock single piece thermowell.

1.21 pH Transmitter with Sensor:

1. Sensors shall be UL / CE listed. pH Transmitter should be wall mounted with inbuilt option of DIN Rail mounting with 0 – 14% Range. The transmitter should have zero and span adjustments for pH of 4 and 7.
2. pH Sensor should be able to withstand 7 bar pressure and temperatures of -20°C to 130°C. The pH sensor should be replaceable. Thermowell for electrode protection compulsory.
3. The output should be 4 – 20mA, with 230V AC Power Supply.
4. The accuracy for the transmitter should be ±0.5% of F.S with ±0.1% Drift / year.
5. The enclosure should be made of Fire retardant ABS with IP66 Protection
6. The sensor should be calibrateable and rerangeable by **COML** protocol on site

1.22 EC Transmitter with Sensor:

1. Sensors shall be UL / CE listed. EC Transmitter should be wall mounted with 0 – 1000µS Range. The transmitter should have zero and span adjustments.
2. EC Sensor should be able to withstand 7 bar pressure and temperatures of -20°C to 130°C. The EC sensor should be replaceable. Thermowell for electrode protection compulsory.
3. The output should be 4 – 20mA, with 230V AC Power Supply.
4. The accuracy for the transmitter should be ±0.5% of F.S with ±0.1% Drift / year.
5. The enclosure should be made of Fire retardant ABS with IP66 Protection
6. The sensor should be calibrateable and rerangeable by **COML** protocol on site

1.23 TDS Transmitter with Sensor:

1. Sensors shall be UL / CE listed. TDS Transmitter should be wall mounted with 0 – 7000 ppm Range. The transmitter should have zero and span adjustments.
2. TDS Sensor should be able to withstand 7 bar pressure and temperatures of -20°C to 130°C. The TDS sensor should be replaceable. Thermowell for electrode protection compulsory.
3. The output should be 4 – 20mA, with 230V AC Power Supply.
4. The accuracy for the transmitter should be ±0.5% of F.S with ±0.1% Drift / year.
5. The enclosure should be made of Fire retardant ABS with IP66 Protection
6. The sensor should be calibrateable and rerangeable by **COML** protocol on site
7. Standard of acceptance: Omicron series TDS-691 or approved equal.

1.24 Water Hardness Analyzer:

1. Sensors shall be UL / CE listed. The measurement principle of analyzer shall be Direct Potentiometry. The electrode shall be Ca-Hardness Ion Selective. The sensor should be noise compensated.
2. The range shall be 0 – 300 mg/l $CaCO_3$. The meter should be able to detect 1 mg/L $CaCO_3$.
3. The instrument should have automatic calibration.

4. The instrument shall have non toxic reagents , NaCl and $CaCl_2$.
5. The instruments shall have Aluminium Enclosure with IP65 protection.
6. The output should be field selectable between 0 – 20mA and 4 – 20mA. The instrument should have lower / upper set points, which shall be field selectable.
7. The sensor should be calibrateable and rerangeable by **COML** protocol on site

1.25 Level Transmitters for water tanks:

1. Sensor shall be UL / CE listed and have linear output signal. The transmitter shall be submersible type.
2. Sensor sensing elements shall withstand continuous operating conditions plus or minus 50% greater than calibrated span without damage.
3. Sensor shall have SS316L diaphragm construction, proof pressure of 2 Bar and burst pressure of 20 Bar Minimum. Sensor shall be complete with 4-20 mA output, with over voltage protection. The accuracy shall be ±0.25% or better. The total error band shall be ±0.5% or better
4. The transmitter shall have IP68 protection with Corrosion resistant Cable. The cable should be vented type cable.
5. The sensor should be calibrateable and rerangeable by **COML** protocol on site

1.26 Level Transmitters for Diesel tanks:

1. Sensor shall be UL / CE listed and have linear output signal. The transmitter shall be capacitance type.
2. Sensor sensing elements shall withstand continuous operating conditions plus or minus 50% greater than calibrated span without damage.
3. Sensor shall have SS316L / PTFE wetted parts, proof pressure of 10 bar and burst pressure of 20 bar Minimum. Sensor shall be complete with 4-20 mA output, with over voltage protection. The accuracy shall be ±0.25% or better. The total error band shall be ±0.5% or better.
4. The resolution should be 5mm.
5. The transmitter shall have explosion proof enclosure IP67 protection with CCOE / Equivalent Government Approval.
6. The sensor should be calibrateable and rerangeable by **COML** protocol on site

1.27 Level Switch:

1. Level Switches shall be UL / CE listed and have SPDT Contacts. The switch shall be Float operated, with top mounting.
2. Switch shall have SS316L wetted parts, proof pressure of 10 bar and burst pressure of 20 bar Minimum. The accuracy shall be ±0.25% or better. The total error band shall be ±0.5% or better
3. The switch shall have IP68 protection,with corrosion resistant cable. The current rating for the switch shall be 15A, 230VAC. Fire retardant ABS enclosure.

1.28 Analogue Differential Pressure Gauge:

1. Gauge shall be CE/RoHS listed .
2. Serial No. should be factory engraved.
3. Country of origin should be United States of America.
4. Safety pressure relief plug at the back.

1.29 Digital Differential Pressure Gauge:

1. Gauge shall be CE/RoHS listed.
2. LED Display with $3^1/_2$ Digit. Analogue output 4 – 20mA, 0 – 10V simultaneously and relay output (2 SPST) with Time Delay option.

3. Country of origin should be United States of America.
4. Die Cast Aluminium enclosure with IP65 protection class.
5. The sensor should be calibrateable and rerangeable by **COML** protocol on site

1.30 Current Sensors:

1. Current Sensors shall be UL / CE listed have a sensing range of 0.25 to 50A AC with 10,20,50A jumper selected..CT material ABS
2. Sensors shall be provided with accuracy of ±2% of F.S.
3. Output should be 0 – 5 VDC
4. Temperature range -20 to 60 Deg.C
5. Plastic housing flammability rating UL94V0 file E194560

1.31 Voltage Sensors:

1. Voltage Transducers shall be UL / CE listed have a sensing range of 0 to 30VDC
2. Sensors shall be provided with accuracy of ±2% of F.S.
3. Output should be 4 – 20mA / 0 – 10VDC ,Optional Isolated output,
4. Temperature range -20 to 60 Deg.C

PART 3 EXECUTION

3.1 **INSTALLATION**

A. All work described in this section shall be performed by system integrators or contractors that have a successful history in the design and installation of integrated control systems.

B. Install system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.

C. Drawings of the BMS network are diagrammatic only and any apparatus not shown, but required to make the system operative to the complete satisfaction of the Architect shall be furnished and installed without additional cost.

D. Line and low voltage electrical connections to control equipment shown specified or shown on the control diagrams shall be furnished and installed by this contractor in accordance with these specifications.

E. Equipment furnished by the HVAC Contractor that is normally wired before installation shall be furnished completely wired. Control wiring normally performed in the field will be furnished and installed by this contractor.

3.2 **WIRING**

A. All electrical control wiring and power wiring to the control panels, NAC, computers and network components shall be the responsibility of the this contractor.

B. The electrical contractor shall furnish all power wiring to electrical starters and motors.

C. All wiring shall be in accordance with the Project Electrical Specifications, the National Electrical Code and any applicable local codes. All BMS wiring shall be installed in the conduit types specified in the Electrical Specifications unless otherwise allowed by the National Electrical Code or applicable local codes. Where BMS plenum rated cable wiring is allowed it shall be run parallel to or at right angles to the structure, properly supported and installed in a neat and workmanlike manner.

3.3 **WARRANTY**

A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.

B. Within this period, upon notice by the CLIENT, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by this contractor at no expense to the CLIENT.

3.4 **WARRANTY ACCESS**

A. The CLIENT shall grant to this contractor, reasonable access to the BMS during the warranty period.

B. The CLIENT shall allow the contractor to access the BMS from a remote location for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period.

3.5 **SOFTWARE LICENSE**

A. CLIENT shall be the named license holder of all software associated with any and all incremental work on the project(s). The owner, or his appointed agent, shall determine which organizations to be named in the "**orgid**" of all software licenses.

B. CLIENT, or his appointed agent, shall be free to direct the modification of the "**orgid**" in any software license, regardless of supplier.

C. The owner, or his appointed agent, shall receive ownership of all job specific software configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and /or configured for use within based controllers and/or servers and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required Ids and passwords for access to any component or software program shall be provided to the owner.

3.6 **ACCEPTANCE TESTING**

A. Upon completion of the installation, this contractor shall load all system software and start-up the system. This contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications.

B. This contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation.

C. Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of CLIENT's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the CLIENT's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

D. System Acceptance: Satisfactory completion is when BMS contractor have performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of CLIENT Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.7 **OPERATOR INSTRUCTION, TRAINING**

A. During system commissioning and at such time acceptable performance of the BMS hardware and software has been established this contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software and accessories.

B. This contractor shall provide 40 hours of instruction to the CLIENT's designated personnel on the operation of the BMS and describe its intended use with respect to the programmed functions specified. Operator orientation of the systems shall include, but not be limited to; the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.

C. The training shall be in three sessions as follows:

1. Initial Training: One day session (8 hours) after system is started up and at least one week before first acceptance test. Manual shall have been submitted at least two weeks prior to training so that the owners' personnel can start to familiarize themselves with the system before classroom instruction begins.

2. First Follow-Up Training: Two days (16 hours total) approximately two weeks after initial training, and before Formal Acceptance. These sessions will deal with more advanced topics and answer questions.

3. Warranty Follow Up: Two days (16 hours total) in no less than 4 hour increments, to be scheduled at the request of the owner during the one year warranty period. These sessions shall cover topics as requested by the owner such as; how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.

SECTION-II: CONDUIT, ACCESSORIES & FIXING ARRANGEMENT

1. RIGID MS CONDUIT/GI CONDUIT & ACCESSORIES

Rigid MS conduits shall conform to relevant Indian Standards. MS ERW conduits protected inside & outside by black stove enamel shall be used as called for in the schedule of quantities.

Conduit upto 32mm dia shall be of 16 G and above that shall be of 14 G.

Joints between conduits and accessories shall be securely made, to ensure earth continuity (screwed joints). All joints shall be fully watertight. Threads and Sockets shall be free from grease and oil.

Conduit fittings and accessories such as inspection boxes, draw boxes and junction boxes shall be of C.I. for concealed conduiting and shall be of M.S. for surface conduiting. All conduit accessories shall be threaded type only.

Conduit runs shall be so arranged that the cables connected to separate systems shall be enclosed in separate conduits.
MS conduits shall be smooth in bore, true in size and all ends where conduits are cut shall be made carefully smooth. Sharp edges shall be trimmed. All joints between lengths of conduits or between conduits and fittings and boxes shall be held firmly together and screwed properly. Connection between screwed conduit and sheet metal boxes shall be by means a brass / GI hexagonal check nut fixed from inside the box and another check nut from outside the box. Smooth PVC bushes from inside the box to be used to avoid damage to wires.
GI conduits if called for in the schedule of quantities shall conform to relevant Indian Standards. These conduits shall be protected by hot dip galvanized coating both inside and outside.

2. FLEXIBLE CONDUITS

Metal Flexible conduits shall be made of heavy gauge MS / GI strip galvanized after making the spiral. Both edges of the strip to have interlocking to avoid opening up.

PVC flexible conduits shall be heavy duty and of FRLS type.

3. LAYING / FIXING OF CONDUITS

Conduits shall be installed so as to avoid steam and hot water pipes. Conduits for LV systems shall be at least 150mm away from the electrical conduits.
Wires shall not be drawn into conduits until the conduits are erected, firmly fixed and cleaned out. Not more than two right angle bends or the equivalent shall be permitted between draw or junction boxes. Bending radius shall not be less than 2.5 times the outer diameter of the conduit.

Conduits concealed in the ceiling slab shall run parallel to walls and beams and conduit concealed in the walls shall be vertical or horizontal.

The chase in the walls required for the recessed conduit system shall be neatly made and shall be of ample dimensions to permit the conduits to be fixed in the manner desired. Conduits in chase shall be held by steel clamps of approved design. The chase shall be filled up neatly after erection of conduits and brought to the original finish of the wall with cement plaster/cement concrete. The spacing between each clamp shall be 60 cm center to center.

Surface conduits shall be fixed by means of spacer bar saddles at intervals of not more than 500 mm from both sides of fittings/accessories. The saddles shall be of 3mm x 19mm galvanized M.S. flat

properly treated, primed and painted securely fixed to support by means of nuts & bolts / raw plugs and brass machine screws.

Where conduits cross expansion joints in the buildings, adequate expansion fittings shall be used to take care of any relative movement.

Conduiting fill area shall not be more than 45%.

Contractor shall submit the conduiting layout to PMC / Owners for approval before start of work. While laying conduiting, care should be taken that water, mortar and dirt etc. do not enter the conduits and boxes.

Conduiting system should be such that it shall facilitate easy drawing of new wires/additional wires at any stage. All junction boxes/pull boxes/ draw boxes shall be completely accessible for inspection, maintenance or for future expansion. While drawing of wires, care shall be taken to avoid damage to the wire insulation.

All joints in the wiring shall be made only at switches, distribution boards, socket outlets, lighting outlets and switch boxes only. No joint shall be made in conduits and junction boxes.

4. METAL OUTLET BOXES

1 MM thick pre-galvanized sheet outlet boxes of suitable size as per the requirement. The outlet box shall be of minimum depth of 50mm unless otherwise specified differently. GI outlet box shall have a brass earth terminal.

5. PLASTIC OUTLET BOXES

Plastic enclosures / outlet boxes where ever required shall be of suitable size as required.

6. CABLING

A. BMS System

Sl. No.	Description	Technical Data Sheet
	Power Cabling:	
1.	Nominal size of cable	**3C x 1.5sqmm., PVC insulated, tinned copper conductor, armoured cable**
2.	Voltage grade (volt)	1100
3.	No. of core size in sqmm.	3C x 1.5sqmm.
4.	Conductor	
5.	Material	Multistrand plain annealed tinned electrolytic grade copper conductor (C1-2)
6.	Max. D.C resistance of conductor at 20°C (ohm/km)	12.20
7.	Shape of conductor	Circular round
8.	Insulation	
9.	Material	PVC Type-A, as per IS: 5831
10.	Insulation thickness (nominal) (mm)	0.80
11.	Insulation thickness (minimum) (mm)	0.62
12.	Core identification	Red, yellow, blue
13.	Inner sheath	
14.	Material	Extruded PVC
15.	Minimum Thickness	0.30
	Armouring	
16	Material	Galvanized round wire Armour

18.	Type of armouring	Round G.I. wire
19.	Nominal size of armour (mm)	1.40 ± 0.04
20.	Outer sheath	
21.	Material	Extruded PVC (Type ST1 confirming to IS: 5831)
22.	Thickness (mm)	1.24 (min.)
23.	Colour of outer sheath	Black
24.	Electrical parameters	
25.	Max. AC resistance of conductor at 70°C (ohm/km)	14.50
26.	Calculated cable reactance (ohm/km)	0.126
27.	Approx. cable capacitance at 50Hz (mfd/km)	0.14
28.	Maximum conductor temperature at the termination of short circuit	160°C
29.	Short circuit rating of conductor for the duration of 1 sec. (KA)	0.17
30.	Continuous current carrying capacity	
31.	In ground at 30°C (A)	21
32.	In air at 40°C (A)	17
33.	Applicable standard	IS: 1554 Pt-1
34.	Nominal over all diameter of the cable in mm	12.2
35.	Minimum bending radius	12xD (where D is the diameter of cable)
36.	For cables pulled with stocking (Newtons)	$9xD^2$ (where D is the diameter of cable)
37.	For cables pulled with pulling eyes N	$50N/mm^2$
38.	Printing	Yes (Provided as per standard)

Sl. No.	**Description**	**Technical Data Sheet**
	Power Cabling:	
1.	Nominal size of cable	**Single cable 2C x 1.5sqmm., PVC insulated, tinned copper conductor, armoured cable**
2.	Voltage grade (volt)	1100
3.	No. of core size in sqmm.	2C x 1.5sqmm.
4.	Conductor	
5.	Material	Multistrand plain annealed tinned electrolytic grade copper conductor (C1-2)
6.	Max. D.C resistance of conductor at 20°C (ohm/km)	12.20
7.	Shape of conductor	Circular round
8.	Insulation	
9.	Material	PVC Type-A, as per IS: 5831
10.	Insulation thickness (nominal) (mm)	0.80
11.	Insulation thickness (minimum) (mm)	0.62
12.	Core identification	Red, Black
13.	Inner sheath	
14.	Material	Extruded PVC
15.	Minimum Thickness	0.30
	Armouring	
16	Material	Galvanized round wire armour
18.	Type of armouring	Round G.I. wire

19.	Nominal size of armour (mm)	0.90 ± 0.05
20.	Outer sheath	
21.	Material	Extruded PVC (Type ST1 confirming to IS: 5831)
22.	Thickness (mm)	1.24 (min.)
23.	Colour of outer sheath	Black
24.	Electrical parameters	
25.	Max. AC resistance of conductor at 70°C (ohm/km)	21.80
26.	Calculated cable reactance (ohm/km)	0.131
27.	Approx. cable capacitance at 50Hz (mfd/km)	0.12
28.	Maximum conductor temperature at the termination of short circuit	160°C
29.	Short circuit rating of conductor for the duration of 1 sec. (KA)	
30.	Continuous current carrying capacity	Supplier to confirm
31.	In ground at 30°C (A)	18
32.	In air at 40°C (A)	15
33.	Applicable standard	IS: 1554 Pt-1
34.	Nominal over all diameter of the cable in mm	11.0
35.	Minimum bending radius	12xD (where D is the diameter of cable)
36.	For cables pulled with stocking (Newtons)	$9xD^2$ (where D is the diameter of cable)
37.	For cables pulled with pulling eyes N	$50N/mm^2$
38.	Printing	Yes (Provided as per standard)

Sl. No.	Description	Technical Data Sheet
	Communication cable	
1.	Nominal size of cable	Communication cable 3C x 1.0 sqmm., PVC insulated, twisted pair, tinned copper conductor, shielded armoured cable (1C for transmitter, 1C for receiver and 1C for grounding) BS: 5308/ IS: 694/IS 1554
2.	No. of core size in sqmm.	3C
3.	Conductor diameter	As per IS: 8130 (0.31mm), Max.
4.	No. of strands in conductor	14
5.	Conductor resistant in ohm/km	As per IS: 8130 (18.20 ohm / km, max.)
6.	Resistance of ATC drain wire ohm/km	As per IS: 8130 (40.1 ohm / km, max.)
7.	Thickness of Inner Sheath	0.80mm, Nom.
8.	Dimension of armour wire	0.90 ± 0.05mm
9.	Overall dia of cable	Supplier to confirm
10.	Insulation thickness (Nominal) Red	0.60mm
11.	Insulation thickness (Nominal) Black	0.60mm
12.	Thickness of Al Mylar Tape	0.025mm, Nom.
13.	Thickness of Polyester Tape	0.025mm, Nom.
14.	Thickness of outer sheath	1.24mm, Nom.
15.	Printing layout and Brightness	Straight & Bright
16.	Physical Test : Before Ageing	As IS-5831
17.	TS of insulation	$12.5N/mm^2$ (Min)

18.	Elongation of insulation in %	150% (min)
19.	After ageing for seven days	As IS-5831
20.	TS & Variation	12.5N/mm^2 (Min) ± 20%
21.	Elongation & Variation	150% (min) ± 20%
22.	Shrinkage	Sample shall not shrink > 4%
23.	Loss of Mass	Should not be > 2mg / cm^2
24.	Thermal Test	80 minute, Min.
25.	Hot Deformation (depth of identation in %)	Insulation should not be deform 50% max.
26.	Heat Shock	Sample should not show any sign of crack
27.	High voltage	1KV applied for 5 minutes
28.	Flammability : Self Extinguishing time after removal from flame	Max. 60 seconds
29.	Length of uncharred portion	Min. 50mm
30.	Limiting oxygen index	29% - O_2 min.
31.	Temperature index	250°C min.
32.	IR test Mohm-km at 27°C	As per IS-694 / 36.7 Megohm km min.
33.	At 70°C	As per IS-694 / 0.037 Megohm km min.
34.	VR at 27°C	$1x10^{13}$ ohm-cm (min)
35.	VR at 70°C	$1x10^{10}$ ohm-cm (min)
36.	Cold Bend test	As IS-694
37.	After wrapping around a mandrel	No sign of crack

Sl. No.	Description	Technical Data Sheet
1.	Part Name	PVC insulated, Twisted pair, tinned copper conductor, CAT-6 Cable
	Specifications	As per IEC 60227, 60331-I/TIA/EIA-568
2.	Conductor size	0.58mm max.
3.	Conductor resistant in ohm/km	73 ohm / km, (max.) at 20°C
4.	Insulation thickness	0.015 ± 0.005mm, Nom.
5.	Outer Jacket thickness	0.38 ± 0.13mm
6.	Max. overall diameter	7.0mm max.
7.	Core colour	Brown/Brown-white, green/green-white, blue/blue-white, orange/orange-white
8.	Bending radius	>15x cables diameter
9.	Mechanical characteristic	
10.	Temp. range	(-) 10°C to 80°C
11.	Bending radius “nD”	6x overall diameter
12.	Sheath	PVC
13.	Electrical parameter	
14.	Voltage rating	300/500V
15.	Frequency	50 MHz
16.	Characteristic impedance at 1 MHz	100Ω ± 20
17.	Mutual capacitance pf/meter	57
18.	Capacitance unbalance real / real	≤300 pF/500m
19.	Capacitance unbalance real / ground at 1 MHz	≤1330 pF/100m
20.	Attenuation	
21.	Near end cross talk	48.3-15 log (f/100m) Min.
22.	Far end cross talk	38.2-20 log (f/100m) Min.

7. CABLE TRAYS

a. PERFORATED CABLE TRAYS

Standard Technical details of perforated cable tray shall be as follows:

SSl. No.	SIZE OF TRAY (Width)	THICKNESS & COLLAR HEIGHT
11.	150mm to 450mm width	2mm thick & 50mm collar
22.	600mm to 750mm width	2mm thick & 50mm collar
33.	900mm to 1200mm width	3mm thick & 50mm collar

Note: Supports shall not be charged extra. It shall be considered to be included in the rate of the tray.

b. LADDER TYPE CABLE TRAYS

Standard technical details of ladder type cable trays shall be as follows:

SSl. No.	SIZE OF TRAY	SIZE OF MAIN CHANNEL OR RUNNER	SIZE OF RUNG & SPACING	CABLE TRAY SUPPORT
11.	900mm to 1500mm	25 x 100 x 25 x 2.5mm	20 x 50 x 20 x 2.5mm @ 250 C/C	50 x 50x 5mm angle @ 1000mm spacing.
22.	450mm to 750mm	20 x 75 x 20 x 2.0mm	20 x 50 x 20 x 2mm @ 250 C/C	40 x 40 x 5mm angle @ 1250mm spacing.
33.	150mm to 300mm	20 x 75 x 20 x 2.0mm	15 x 35 x 15 x 2mm @ 250 C/C	40 x 40 x 3mm angle @ 1500mm spacing.

Hangers shall be minimum 10mm dia GI Round bar.

Fixing /supporting arrangement shall be as approved by the Consultant / Owner / PMC

Hardware to be used in cable tray system shall be galvanized or zinc passivated.

Note: Supports shall not be charged extra. It shall be considered to be included in the rate of the tray. All structural steel shall be according to the latest revision of IS: 226 & 808.

8. AUTOMATED METER READING (Pre-Paid Application)

a. About AMR System:

Automated Meter Reading (AMR) system is combination of electronic meter and software to collect/mange revenue and electrical energy consumption / generation using electronics pre-paid energy meter.

System should be able to communicate using wired technology. System should be capable to detect energy leakage, pilferages, meter tempering, which in turns results into energy saving & better management. System should have a web based software, which can enable customer and utility company to view, recharge and mange system using computer, tablet and mobile phone with all real time information.

b. System Requirements

Followings are major expectation from the system:

1. Pre-paid dual source Energy Meter for single/three phases with load capacity of 10 Amp to 60Amps, with / without Current Transformers, and with non-volatile memory.
2. Floor meters would be wired in group up to 32 nos to one sub GHz wired modem, which do not require GSM/GRPS system and all floors data would be collected to data logger in one tower.
3. Data would be collected to central server, meter recharging would be done from central location.
4. Payments would be collected from end user by service provider.
5. Information to customer over – Customer information Display / SMS / email / Website.
6. Option to recharge meter using cheque / DD / online.
7. Option to cut energy or resume energy on management decision, whether have meter is recharged or not. The meter should have in-built auto-cutoff relay for tripping of supply. The relay shall be of suitable fault rating i.e. minimum 10kA or as applicable for the respective meter board / panel.
8. Each customer would have its login and password, so customer can view his consumption, edit his profile like mobile email etc.
9. Customer should also be enabled recharge using his login online.
10. Customer can view his consumption / recharge / demand reports with 24 readings a day.
11. Configurable tariff setting, which should enable following options: Common area charges, Maintenance charges, electricity tax, GST, T&D (Transmission and Distribution) loss etc. for both Grid Supply and Supply through Stand-by D.G. Set.

c. System Architecture:

Proposed AMR solution shall be using best of all communication systems to make it robust and cost effective. Meters on the floors would be wired using RS485 communication & networking system and floor to floor communication would be done using sub Giga Hz system, which is also collecting and storing data up to 2TB. On every hour or given interval all collected data would be uploaded to server. This device would also be collecting all actions/triggers send by server on real time basis. Incase failure of GPRS/Internet connection data would be sent using SMS packets.

Customer should be able see his reading from the web based software. Each customer would have his login to edit his profile, manage his password, recharge meter using credit/debit card, view his consumption / recharge / demand report in tubular as well as graphical mode in printable mode.

On successful recharge confirmation email and SMS would be sent to customer. Customer will also receive weekly message/email for his current balance, peak load and consumption of the week.

The software shall be capable to convert recharge amounts into meter readings in kWh, and vice-versa. Rate per kWh for different power sources shall be fed manually by the Facility-in-charge.

Low balance message & email also be sent to customer. Customer can store more than one email id and mobile number for SMS.

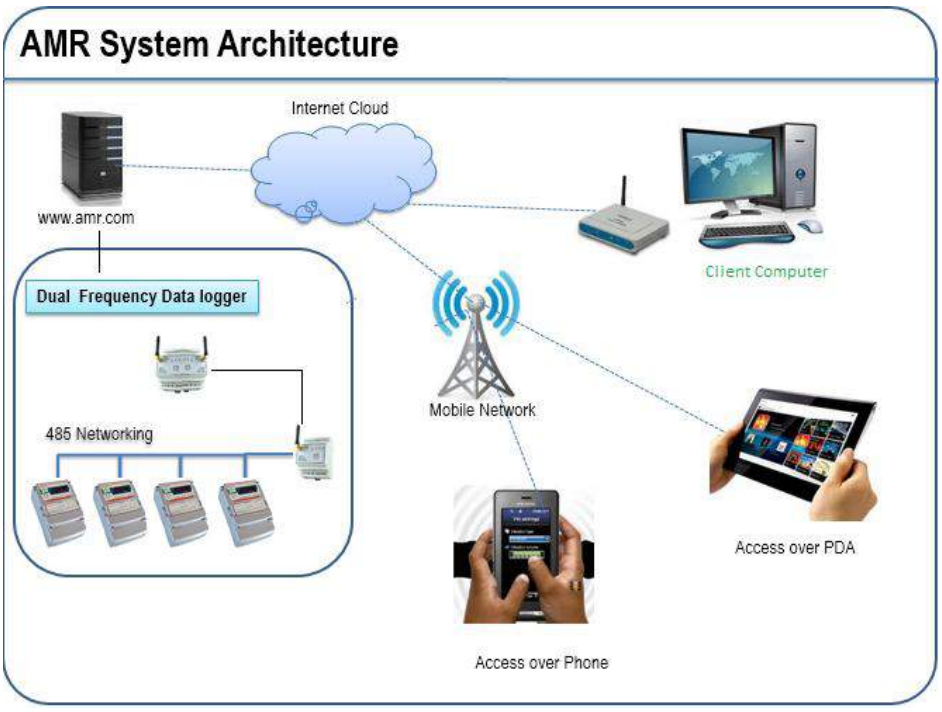
Exclusion calendar give facility to customer that if balance finishes on given intervals of the day or particular all days or special days as defined would provide disconnection immunity.

Access of the system to customer should be available from his internet enabled mobile phone/ PDA/ Computer, so software should follow minimum standards called HTML5 on client side.

Software should be follow strictly n-tier architecture to handle all these customer without lagging performance.

Software should have separate scheme which enable screen level permissions and site wise data view / modification rights.

System alerts, should be sent on site administrator phone / email so immediate actions / provision can be done to prevent the technical glitches or problems.



d. Hardware or devices Specification:

Following devices required for AMR System:

1. Dual Source Electronic Energy Meter – Rating 10A~60A Single / Three Phase, with / without CT.
2. Wired Modem sub Giga Hz support Mess Network Technology.
3. Dual Frequency Data logger support sub Gig Hz and Cellular Network.

4. Central Server with OS, Office and Free MS SQL.
5. Static IP.

1. Dual Source Energy Meter Specifications

Accuracy:	Class 1 (Default) IEC 61036, CBIP 88
Sensing/Measurement:	True RMS, 1 Sec update time, 4 Quadrant Power & Energy (RD Option
Input voltage:	4 Voltage inputs (VR, VY, VB, VN); Programmable 230 or 415V LL Nominal (Range 80 to 550V LL), Primary Programmable up to 999 kV, Burden: 0.2VA Max. Per phase.
CT operated input current:	Current inputs (AR, AY, AB) 50mA- 6A (Field configurable 1A or 5A),Primary Programmable up to 99 kA for CT operated one, Overload: 10A max continuous, 50A max for 3 sec. for 5A or 10 times basic whichever is lower, Burden: 0.5VA Max. Per phase
S/C Fault Withstand Capacity	minimum 10kA or as applicable for the respective meter panel / board.
Whole current operated:	10 - 40A or 15 - 60A or 20 - 80A
CT PT Ratio Max:	2000 MVA Programmable
Display Resolution:	1 row, 6 digits, (Integrated 6digits) 10mm
Communication:	RS485 serial channel connection, Industry standard. Modbus RTU Protocol (RS232 optional), Baud rate: 1200 bps to 19200 bps. (Preferred 9600 bps), Isolation: 2000 volts AC isolation for 1 minute Between communication and other circuits.
Gas / water input (optional):	Factory configurable Digital input with Maximum Frequency 3 Hz OR Analog Input 4-20mA or 0-20mA programmable at field or 1-10DC voltage
Weight:	Unpacked: 1650 gms, Packed: 1850 gms
Mechanical Specification:	for 3phase prepaid meter, Dimension Bezel: 173 × 262 mm (Depth 82mm behind bezel)

2. Wired modem Specifications:

Frequency	: Sub GHz (Preferably 865Mhz).
Input Voltage	: 220Volt AC
Antena	: 2.3 db
Serial Port baud rate	: 9600, 8, n, 1
Devices Connectivity	: RS232 / RS485
Max. Device s supported	: RS485 32Nos.
Max. Devices in cluster	: 30 Nos

3. Data logger Specifications

Communication Specifications: -

Ethernet Port	**:** Connector: RJ45.
Speed	: 10/100Mbps.
Protocol	: ARP, IP, ICMP, UDP, TCP, HTTP, DHCP.
Mode	: TCP Server/Client; UDP Client.
Configuration	: HTTP, UDP.
Security	: Setup Password & Connect Password.
Protection	: Built in 1.5KV Magnetic Isolation.
Dual Frequency	: Sub Giga Hz and 900/1800 MHz dual band.
Local Data storage	: SD Card up to 32 GB (Required 2GB)
SIM	: GSM/GPRS/3G 32k/64k support.

Serial Port :

Ports	: 2 Ports (All 2 Ports can be used as RS232).
Speed	: 300 bps to 230 Kbps.
Baud rate	: 9600
Parity	: None, Odd, Even.
Data Bit	: 5, 6, 7, 8.
Stop Bit	: 1, 2.
RS232 Pins	: RX, TX, GND, RTS, CTS, DTR, DSR, DCD.
RS-422	: Rx+, Rx-, Tx+, Tx-.
RS-485	: Data+, Data-.
Interface Selection	: Through the HTTP Configuration Utility.
Protection	: 15KV ESD for all signals. Surge Protection on all RS485 / RS422 lines.
Termination	: Resistor built in for RS422/RS485.
LED's	: SYS, LINK, 10M, 100M, LAN Tx, LAN Rx.
Power	: 9 to 12 V DC, 1A max.
Operating Temp	: 0 to 50 deg C.
Relative Humidity	: 10 – 90 % Rh. non-condensing.
Dimensions	: 168 * 123 * 27 mm (W * D * H).
Weight	: 340 gm.

Electronic Specifications:

Site Program	: Site Programmable via easily accessible dip switches.
Features	: Option program from remote or using SMS, option to configure 2 or more phone to receive SMS, configure auto SMS to 2 nos.

Electrical / Environmental Specifications:

Aux. Supply : 90V- 270V AC/DC (3 VA max.)

4. Meter Display Unit

Type of Display : LCD 2X16 character display with low power consumption

Communication	: RS232/485.
Button	: 3 Button - Left/Right/OK
LED Indicator	: 2 LED indicators for Meter ON / Trip and 2 LED Indicators for Earth Leakage / Healthy Condition, programmable.

e. <u>Software Specification:</u>

Tariff application details:

The pre-paid energy metering system with the software shall be used to implement following types of tariff

Application:

i. 4 Flat rate of energy
ii. 4 Common area energy charges Flat rate / per sq ft
iii. Energy / VAT tax / GST on fixed percentage basis
iv. Standing charges (like fixed KW charges & monthly maintenance charges)
v. Exclusion calendar definition:
The energy meter shall not disconnect supply in these defined hours of the day. For example if evening 10 pm to morning 8 am is defined as happy hours then the meter shall not disconnect during this time period even when the energy meter runs out of credit.

vi. Holiday definition.
The supply shall not be terminated on these specified days, for example if Sunday is defined as a holiday then the switch will remain on Sunday even if the pre payment energy meter runs out of credit.

Implementation of the Register switching using Pulse Input in case of dual register (for DG consumption measurement)

The Software
Measures electricity consumption and decrements the credit based on the cost per unit of electricity.

Display Unit
A remote display which when connected to the meter allows all features to be conveniently accessed from any room in the house. Both these shall be connected with the help of RG-11 cable.

Prepayment for mains and DG
In prepayment software there shall not be a problem of deducting money from the consumers account because of the fact that DG shall have different tariff and mains shall have different tariff. With the use of Pulse Input Logic, meter shall be intelligent to identify the DG & mains. And the software shall deduct the amount according to DG and mains both.

The pre-paid metering system shall be essentially “a pay as you go” System, which means that the system shall help the consumer to choose when and how much of electricity to be purchased. Also it shall enable a system of trouble free purchase of electricity with multiple options to the consumer.

Features of the pre-paid metering software shall be as follows:
1. Option to define Tariff Headings under ledgers - Main Supply, DG Backup, Other Charges and Interest & Late Payments. One can have as many heading as intended.

2. Option to define Taxes on Each Tariff Heading.
3. Option to capture dual energy - Mains & DG and Over Demand of Main & DG.
4. Option to Recharge by Cash/Cheque/Credit/Debit Card & online payment using Credit/Debit/net banking (Optional).
5. Option to view meter reading online from any location by web (optional).
6. Option to send SMS & email on low balance, power cut, over demand, recharge.
7. Option cut supply incase reaching minimum balance amount.
8. Option for bank reconciliation.
9. Option for reconnection reconciliation in case of cut off of electricity.
10. Option to put advertisement for defined period.
11. Option defines company log and terms & conditions.
12. Option to define SMS template & email template as standard replies.
13. Reporting energy analyzing reports:
    1. Mains/DG energy consumption behavior.
    2. Peak Load behavior.
    3. Least Load behavior.
    4. Month Wise Consumption behavior.
14. Inside room Service using Customer Information Display
    1. Indication of current energy in use - Grid / DG.
    2. Meter reading of Mains / DG / Maximum Demand Load.
    3. Available Balance.
    4. Last recharge amount.
    5. Custom Message to be displayed.

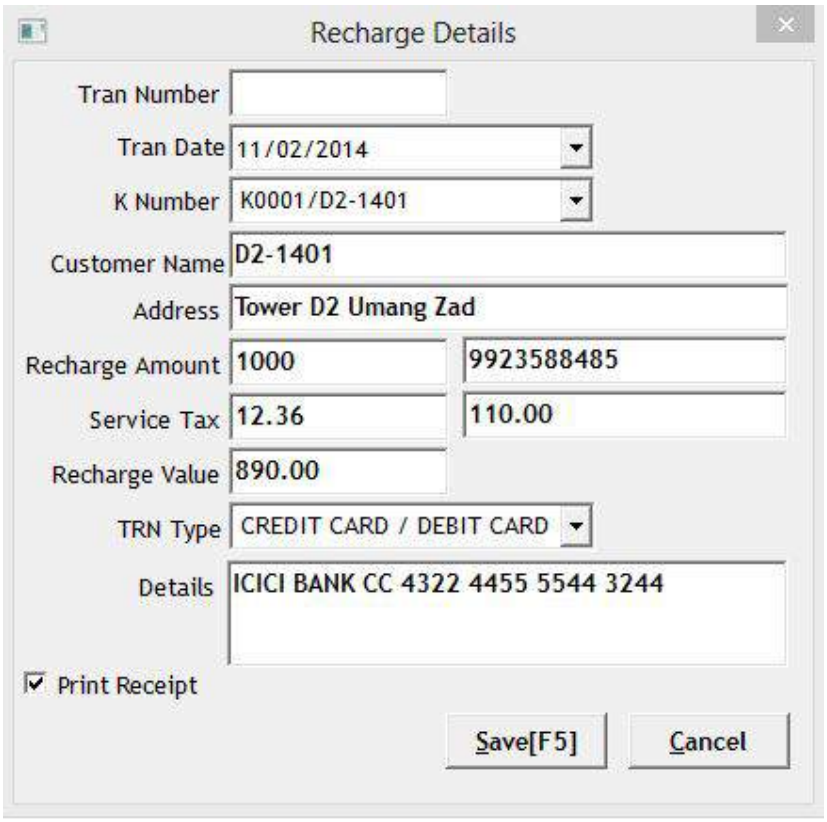
a. Monitory
   i. Reduced cash flow cycle
   ii. Reduced cost of revenue collection
   iii Reduction in administrative cost (Record keeping etc.)

b. Operation
   i. Introduction of an automatic revenue collection system
   ii. Reports on revenue management available daily
   iii. Error free reporting

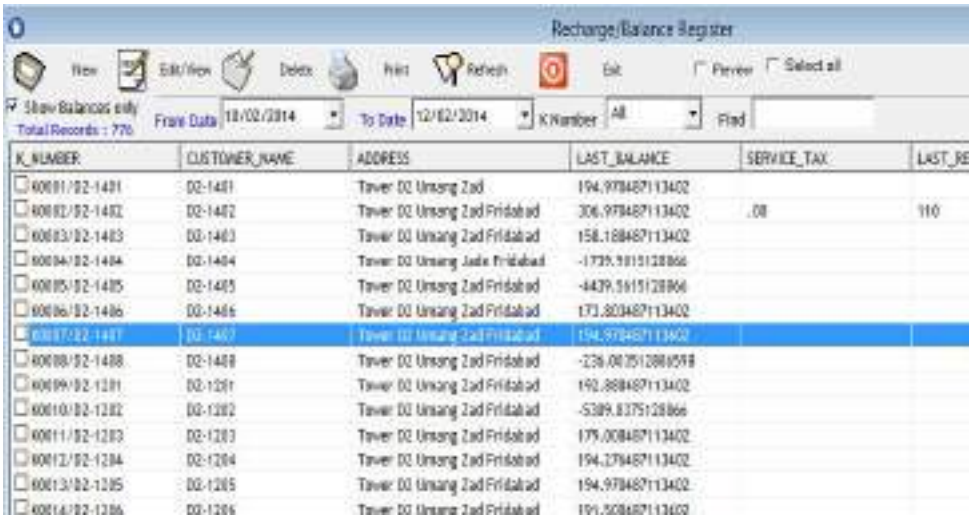
c. Consumer relationship improvement
   i. No complains for defective meter reading
   ii. Friendly credit purchase hours
   iii. Budgeting
   iv. No hidden charges

Some Screen shots

Recharge a meter



View balance



Operator Dash Board

K_NUMBER	METER_MODEL	METER_ID	METER_LOCATION	CUR_KWH_MA...	CUR_KWH_DG	DATE_TIME...	DATA_DURATION	LAST_BALANCE
K0001/D2-1401	M306	4	D2-1401	0	0	15/10/2013...	171436	194.97048711...
K0002/D2-1402	M306	5	D2-1402	0	0	15/10/2013...	171436	306.97048711...
K0003/D2-1403	M306	6	D2-1403	10.6	0	15/10/2013...	171436	158.18848711...
K0004/D2-1404	M306	7	D2-1404	557.6	0	15/10/2013...	171436	-1739.901512...
K0005/D2-1405	M306	8	D2-1405	1335.6	0	15/10/2013...	171436	-4439.561512...
K0006/D2-1406	M306	1	D2-1406	6.1	0	15/10/2013...	171435	173.80348711...
K0007/D2-1407	M306	2	D2-1407	0	0	15/10/2013...	171435	194.97048711...
K0008/D2-1408	M306	3	D2-1408	124.2	0	15/10/2013...	171435	-236.0035128...
K0009/D2-1201	M306	12	D2-1201	0.6	0	15/10/2013...	171435	192.88848711...
K0010/D2-1202	M306	13	D2-1202	1586.4	0	15/10/2013...	171435	-5309.837512...
K0011/D2-1203	M306	14	D2-1203	4.6	0	15/10/2013...	171435	179.00848711...
K0012/D2-1204	M306	15	D2-1204	0.2	0	15/10/2013...	171435	194.27648711...
K0013/D2-1205	M306	16	D2-1205	0	0	15/10/2013...	171435	194.97048711...
K0014/D2-1206	M306	9	D2-1206	1	0	15/10/2013...	171435	191.50048711...
K0015/D2-1207	M306	10	D2-1207	553.7	0	15/10/2013...	171435	-1726.368512...
K0016/D2-1208	M306	11	D2-1208	63.9	0	15/10/2013...	171435	-26.76251288...
K0017/D2-1101	M306	20	D2-1101	5.9	0	15/10/2013...	171435	174.49748711...
K0018/D2-1102	M306	21	D2-1102	0.1	0	15/10/2013...	171435	194.62348711...
K0019/D2-1103	M306	22	D2-1103	0	0	15/10/2013...	171435	194.97048711...
K0020/D2-1104	M306	23	D2-1104	0.9	0	15/10/2013...	171435	191.84748711...
K0021/D2-1105	M306	24	D2-1105	0	0	15/10/2013...	171435	194.97048711...
K0022/D2-1106	M306	17	D2-1106	0	0	15/10/2013...	171435	194.97048711...

SUB HEAD M. TECHNICAL SPECIFICAITON OF ACCESS CONTROL SYSTEM

1. Access Controller:

The control panel shall be compatible with Access Control software.
The control panel shall incorporate microprocessor-based, digital technology, using high speed processing for maximum reliability.
The system shall use distributed intelligence architecture, with control panels operating independently of one another.
All database information shall be stored at the control panel level.
All decision-making shall be performed at the control panel, eliminating degraded mode operation.
Proprietary software programs and control logic information used to coordinate and drive system hardware shall be stored in FLASH Memory.
The system shall be flexible and modular in design, allowing easy expansion.
The control panel shall have FCC, CE and C-TICK listings and approvals.

1.1 Control Panel Configuration

The control panel shall provide TCP/ IP communication to the host software and RS-485 multi-drop communications to downstream panels.
The Ethernet and RS-485 multi-drop communication configurations shall be standard.
The control panel shall be able to operate in local and shall be able to connect with WIN-PAK for remote configurations.
The RS-485 multi-drop total distance shall be 4,000 feet with a maximum of thirty-one PRO3000 control panels, without the use of modems or line drivers. If installation requires distances longer than listed above, a line driver or modem shall be used.
For maximum reliability, each control panel shall support a maximum of two readers or keypads.
The distance between card readers and the control panel shall be up to 500 feet wired.

1.2 Control Panel Requirements

1.2.1 Reader Interface

The panel shall provide interfaces for the card readers. It shall operate with card reader that produces a standard Wiegand (Data 1/Data 0) or Clock and Data communication output. The following requirements shall also apply:

- Each panel shall support two card readers, each of which may be up to 500 feet from the panel.
- Up to 128 unique card formats shall be supported.
- The panel shall support an integrated card reader/ keypad.

1.2.2 Input Points

A control panel shall provide maximum 8 supervised input points.
The control panel shall support non-supervised and supervised inputs via end-of-line resistors.
Supervised inputs shall report alarm, normal and trouble conditions. Both non-supervised and supervised input points shall be normally opened or closed point selectable.

1.2.3 Output Points

The control panel shall provide a minimum of four (4) single-pole, double-throw (SPDT) form C relays, rated for 28 VDC @ 3 Amp resistive.

1.2.4 Card Readers/ Keypads

The control panel shall support card readers using Wiegand technology.

1.3 Control Panel Features

1.3.1 Card/ Key code Capacity

The control panel shall store up to 55,000 cards/key codes.

1.3.2 Buffer Capability

The control panel shall support a buffered mode of operation. When operating in the buffered mode, the control panel shall store all transactions in memory, rather than transmitting them through the communication loop. The control panel shall transmit the buffered (stored) information upon request.

The control panel shall buffer 45,000 transactions.

1.3.3 Format Commands

The control panel shall store up to 128 format (software) commands, allowing use of cards with various bit structures and encoding schemes.

1.3.4 Site Codes

The control panel shall store up to 8 site codes for card use.

1.3.5 Cards (digits)

The control panel shall be capable of recognizing card numbers up to 16 digits in lieu of the standard Wiegand card formats.

1.3.6 Local Anti-Passback

The control panel in the system shall support an anti-passback mode, where cardholders are required to follow a proper in/ out sequence. A selectable mode of operation to allow for anti-passback forgiveness to occur at midnight shall exist. When selected, at midnight all in/ out status of the card is set to a learn mode so the next use of the card will set the in/ out anti-passback rules until the next time forgiveness is applied.

1.3.7 Global Anti-Passback

Supported as a system function, Global Anti-Passback allows the panels on the same drop-line, so enabled, to provide other panels so enabled, the status of in/out card reads for the sake of creating an anti-passback zone using more than one control panel. This mode of system operation shall not rely on the system computer to control in/out status.

1.3.8 Personal Identification Numbers (PINs)

The control panel shall support the use of card readers in conjunction with keypads, in which users are required to enter a PIN, followed by a card, to gain access.

1.3.9 Time Zones

The control panel shall store up to 127 time zones:

- Each time zone shall include a start time, end time, day of week specification and holiday specification.
- Time zones may be assigned to cards via access levels to define when the card is allowed access.
- Time zones may be assigned to input points, to define when the input points are shunted (deactivated).
- Time zones may be assigned to output points (relays), to define when the output points are energized, for timed control of doors or devices.

1.3.10 Input Points

The user shall have the ability to assign shunt times to input points, from 1-63 seconds, minutes, or hours.

The user shall have the ability to assign debounce times to input points, from 1-255 seconds.

1.3.11 Output Points

The user shall have the ability to assign pulse times to output points, from 1-63 seconds, minutes, or hours.

1.3.12 Interlocking

The user shall have the ability to interlock selected input and output points, in any combination. An interlocked input or output point shall take action based upon a change of state from another input or output point.

1.3.13 Holidays

The control panel shall recognize up to 255 days as holidays, for override of normal system operation.

1.3.14 Card Reader/ Keypad Specifications

System card reader/ keypad shall be Wiegand card format.

1.4 Power Requirements

12 VDC @ 1.5 Amps

2. Standard Proximity Card Readers with Wiegand Communication:

The card readers with Wiegand Communications shall be provided with or without a keypad. The standard card reader must offer the following features:

a. UL 294, Industry Canada RSS-210, and CE Certified
b. Low Power/ Surface Mount Card Reader
c. ADA compliant, built-in audible buzzer
d. Host LED control and tamper output
e. Hidden mounting screws deter vandalism
f. LEDs for access and card reader status
g. Wiegand output
h. Potted for superior weather-resistance
i. 5~16VDC Input Power
j. Read Range: 10.2 cm
k. Temperature Range: -31° C to 63° C
l. Humidity: 0 - 95%, non-condensing
m. Dimensions : 145mm H x 43mm W x 20mm D

3. Finger Print with Proximity Reader

CPU	533MHz DSP
Memory	8MB flash + 8MB RAM
Fingerprint Sensor	500 dpi optical sensor
Identification Speed	2,000 match in 1 second
Fingerprint Capacity	10,000 templates (5,000 users, 2 fingerprints per user)
Log Capacity	50,000 events
RF Card	HID Proximity (125 KHz)
Operation Mode	Fingerprint, RF Card, RF card + Fingerprint
Network Interface	TCP/IP, RS485
Wiegand	Configurable up to 64 bits
Display	Multi-color LED
Audio	Multi-tone buzzer
Power Supply	12V DC (Min. 500mA and above)
Operating Temperature	-20°C ~ 50°C
Certification	CE, RoHS

4. Proximity Cards

a. The access card shall have ISO standard size and thickness.

b. The access card shall be "Passive" (non-battery operated) proximity technology.

c. The access card shall accept direct PVC printing of text, photos and graphics.

d. The access card shall be slot punched on the short edge of the card for a vertical/ portrait oriented photo, shall be offered with multicolor custom graphics.

e. The access card shall have an operating temperature of -45 to 70 degrees Celsius, and shall have an operating relative humidity of 5-95% non-condensing.

f. The read range of the access card shall be extremely consistent, and not be affected by body shielding or variable environmental conditions

5. Electro Magnet Lock

a. The electromagnetic lock shall operate on 12V DC/ 24V AC.

b. The Electro Magnetic lock shall have capability of holding force up to 600 LBS on single leaf & double leaf door.

c. UL certified

6. <u>Access Control Software</u>

The system equipment and installation shall comply with all provisions.

The basic components of the Security Access Control and Alarm Monitoring (SACAM) System shall include:
The Integrated Access Control System (ACS) shall function as an electronic access control system and shall integrate with alarm monitoring, ID badging and database management into a single platform.

The ACS shall be true 3-tier server client architecture. It shall consist of Database Server, Communication Server, and User Interface. These components shall run on a single computer or on multiple computers, allowing flexibility in configuring a networked system.

Multi-level Password Protection: The ACS application shall provide multi-level password protection, with user-defined operator name/ password combinations. Name/ password log-on shall restrict operators to selected areas of the program.

Supervised Alarm Points: The system shall provide both supervised and non-supervised alarm point monitoring.

Access Control Functions: The ACS shall include the following access control functions: validation based on time of day, day of week, holiday scheduling, site code and card number verification, automatic or manual retrieval of cardholder photographs, and access validation based on positive verification of card type Standard), card, card and PIN, card or pin, pin only and Site Code only.

Anti-pass back modes shall include: hard (no forgiveness), soft (allows access but generates an alarm event)

Alarm Events: The ACS shall include a feature where alarm events with defined priorities shall be able to pop-up automatically in an Alarm event window for operator attention. The pop-up shall display the name of the event (reader, alarm point, cardholder, or system alarm), time, date, site, account, if a card event the card number, type of event and cardholder name. An event counter shall also display the number of times the event was reported to the Alarm event monitor prior to Acknowledgement or Clearing the event. Event instructions shall be made available by double clicking on the event. The Alarm event window shall allow the operator to initiate a physical response to the event as well as a written response. Responses shall include but not be limited to: acknowledge, clear, open a pre-programmed floor plan, energize, de-energize, pulse, time pulse, add comment, shunt, or un-shunt.

Shall support "Duress" feature, where a PIN is used in conjunction with a card read; the numbers of digits are selected using the keypad where the PIN number is a value different from the normal PIN.

Shall provide a mode of system operation that allows acknowledged alarms to be automatically cleared.
Shall provide a mode of system operation where when an acknowledged, but not cleared event will be reissued requiring acknowledgement when the event changes to an alarm or trouble state.

Shall support multiple card reader technology including: Proximity, Wiegand effect, Biometrics, Magnetic stripe, Bar Code, Keypad, Card/keypad (PIN), High-speed long range Vehicle ID, and Smart Card.

Shall provide the ability to initiate an email (via SMTP) or page to a paging system based on a transaction state/Event or Alarm.

Shall include a "host grant" mode of operation that requires the host computer to grant accesses to "valid" cards. An alternate host grant mode shall allow the card access information to be downloaded along with unlocking the door for "valid" cards.

7. Cards & Card Holders

A. Cardholder information shall include unique card number up to 20 digits and optional Personal Identification Number up to 6 digits.

B. Shall allow multiple cards per cardholder. Every card can be assigned with 32 Access Levels.

C. Provides special card options that shall include, but are not limited to: Time zone reference, which defines valid time, visitor use, which provides a specified activation date and expiration date (spanning years), Trigger control value, which can initiate a predefined procedure at the intelligent control independent from any control function from the system computer.

D. Shall provide a card "Trace" function. The Trace function shall allow normal access control, but will provide a tracking alarm at the system monitor.

E. Shall provide the ability to store digital images of cardholder or other digital images such as property or family members.

8. Access Levels

A. Access level shall provide restricted access to the card holders for various areas in the access control system based on various Time of the day, week, and special days and Location/ Door.

B. ACS shall support defining of unrestricted number of access levels and any number or doors/ readers can be added in one access level.

C. ACS shall support custom Access Level where by Access can be granted or revoked for a specific door only.

9. Reports

A. Shall provide a feature to generate a history report for an alarm point(s) state. An alarm point state shall be defined as Normal, Alarm, Trouble, or Ajar, Communication, ground fault, power, panel reset, low voltage, panel tamper, and loop communication.

B. Shall provide a feature to generate a Device actions report, which provides information on how the system Device is configured including detailed configurations.

C. Shall provide a feature to generate a history report for a card(s) state. A card state shall be defined as Normal, Trace, and Not Found, Anti-Pass back Violation, PIN Violation, Time Zone Violation, Site Code Violation, or Expired card. Additional search criteria shall include cardholders that meet up to at least 3-note field restriction and filter the report with defined reader location(s).

D. Shall provide complete database reporting of all data programmed into the system data files.

E. Shall provide feature to generate a report based on the frequency of usage of a card. The report shall allow the operator to define a time/ date period, a minimum and maximum usage limit, a means to define which reader or readers should be used to filter the report and the ability to further define the type of card to be reported on based on user defined field selections. This report shall also provide a disposition function. The cards meeting the filtering criteria shall be acted upon based on the disposition setting. Disposition settings shall include but not be limited to: Report only, De-activate the card or Re-assign to a specified an access level. This report shall be available in the event scheduler. When defining when to run the report an option to select the number of previous days to run the report against shall be provided. As an example a scheduled weekly report for the last 14 days could generate allowing for an overlap of time if desired.

10. Tracking/ Muster Report

A. A tracking feature shall allow the system operator to identify an area and the person(s) in that area.

B. Areas shall be defined by readers representing an IN or OUT read status.

C. Defined areas shall provide an automatic update of how many cardholders are in the area.

D. A view displaying all card holders in a defined tracking or muster area shall have the ability to be sorted in columns where by clicking on the column the data in the column shall be sorted. At a minimum, the columns can be sorted by: Card Number, Status, Card Holder, Reader, and Time/ Date.

E. A Muster area shall be defined by a reader(s) used to “muster” individuals in the event of an emergency.

F. Reports shall be generated for all muster or tracking areas in the system.

G. Tracking areas shall include “nested” areas. Nesting allows for various reports from a large area to smaller areas within the large area.

H. A Tracking and Muster area screen shall be continually updated with the most recent card activity, therefore minimizing the time required generating a report.

10. 3rd Party interface

The System shall have an existing standard API for integration with other 3rd party applications.
Alarms/ Events can be exported to 3rd party application if required with the help of these API.
Card Holder enrollment and de enrollment can be done from a 3rd part application with the help of these API (OPTIONAL).

11 BOOM BARRIERS

1. Electromechanical Automatic Barrier

a. The actuator shall operate on 230V 50 Hz single phase AC power supply and shall consume not more than 300 W during any and all operation modes. The control panel shall operate on 230 V 50 Hz single-phase power supply and shall not consume more than 100 mA.

b. The opening time of the system shall not be more than 12 seconds for 6 mtr & above Boom length and not more than 4.5 seconds for 4.5 mtr. & below Boom length.

c. The aluminium bar shall be of hollow rectangular type **(Minimum size 100x70mm)** with reflective stickers. The length of the bar shall be as specified. It should be possible to have an articulated or fenced bar.

d. The system shall incorporate electric limit switches. These shall be housed within the actuator unit and shall be adjustable.

e. The ingress protection for the actuator shall be IP24 and the ingress protection for the control panel shall be IP54.

f. The system shall operate properly in environmental temperatures -5° C to +55° C.

g. The system shall have a quick release key for manual operation during power failure or emergency , fork rest to support during closed position.

h. The system shall be capable of being operated 600 times in 24 hours.

i. The system should be UL/CE approved and shall be manufactured by a reputed manufacturer who shall be certificated under the ISO 9001 series quality procedures.

2. Flap Barriers for pedestrians entry and exit

a. The Automatic Flap barrier shall have UL & CE Certifications.

b. The flap barriers shall be SS finish as approved.

c. The Flap barrier should incorporate photo beam detector for protection.

d. The flap barrier shall have the torque of 3Nm with the protection of IP 54.

e. The flap barrier shall have the opening time of 0.4 Sec with Built in Thermo Protection.

f. Operation through switch and access control reader.

3. READERS

i. Long-Range Reader

a. The card reader shall be a Long Range proximity card/ Prox-Linc WS tag reader.

b. The card reader shall read the encoded data from the access card and/or transponder and transmit the data back to the controller, giving an audible and visual indication of a properly read card.

c. The reader shall not be larger than 12.0" x 12.0" x 1.0".

d. The reader shall have a typical read range of 9 to 11 feet with 1.0A at 6.5V DC, 0.4A at 15V DC.

e. The reader shall be provided with an internal tamper switch that will indicate an alarm condition if an unauthorized attempt is made to disassemble the unit.

f. The card reader shall be sealed to a NEMA rating of 4X, and all internal electronics will have conformal coating to provide a high degree of environmental protection.

g. The reader shall be listed under UL 294 as an access control system accessory, and shall have the following certifications: Canada/UL 294, Canada/UL 1604 (Hazardous Location Model only) FCC, Canada Radio, EU and CB Scheme Electrical Safety, EU – R&TTE Directive, CE Mark, Australia C-Tick, New Zealand.

h. The reader shall have separate terminal control points for the green LED, the red LED, and the audible indicator.

i. The reader shall be fully weatherproof, and shall have an operating temperature of -5 to 55 degrees Celsius, and shall have an operating humidity of 5-95% non-condensing.

j. The reader shall be made from polycarbonate material, and shall be charcoal gray or as approved.

k. The reader shall transmit data at a 125 kHz frequency.

l. The reader shall communicate in a Wiegand protocol interface, and be compatible with all standard access control systems.

m. Reader shall be programmable read repetition rate for one shot or multiple reads prevent.

n. Reader shall utilizes passive tag technology.(Without battery)

o. Reader shall be of industry standard Wiegand and RS-232 data output.

p. Reader shall be compatible with the control module& software as specified.

q. The reader shall have automatic tuning capability to continuously optimize antenna tuning for environmental changes to provide consistent read range.

ii. Standard Card Readers with Wiegand Communications

The card readers with Wiegand Communications shall be provided with or without a keypad. The standard card reader must offer the following features:

n. UL 294, ULC, and CE Certified.
o. Low Power/Surface Mount Card Reader.
p. 600,000 pass read head.
q. Bi-directional card swipe.
r. Weatherized Finishes.
s. LEDs for access and card reader status.
t. Card and PIN data shares same output lines.
u. 12VDC or 5VDC Input Power.

iii. Proximity Cards

g. The access card shall have up to 84 programmable bits of Wiegand formatted information for universal compatibility with all Wiegand interface reader applications.

h. The access card shall be "Passive" (non-battery operated) proximity technology.

i. The access card shall have a permanent ink jet or laser engraved identification number printed onto it. The card numbering options shall be Sequential Matching i.e. The internal identification numbers and the external ink jet numbers shall both be sequential and shall match (i.e. internal numbers 1-100, external ink jet numbers 1-100).

j. The access card shall be slot punched on the short edge of the card for a vertical/ portrait oriented photo, shall be offered with multicolor custom graphics.

k. The access card shall have an operating temperature of -5 to 55 degrees Celsius, and shall have an operating relative humidity of 5-95% non-condensing.

l. The read range of the access card shall be extremely consistent, and not be affected by body shielding or variable environmental conditions

iv. Passive long range cards for the vehicles (wind-screen)

a. Cards shall have the read range of 9 feet to 11 feet when WS tag is attached by self-adhesive to the inside of the vehicle's windshield.
b. Cards shall be Passive proximity at 902-928 MHz Frequency-hopping limits interference and requires no FCC license.
c. Cards shall have Prox-Linc WS tags can be programmed with trillions of unique codes for the security.
d. Cards shall have no battery; capable of an infinite number of reads to assure years of maintenance-free operation.
e. Cards shall have Wiegand format up to 2K user-definable bits; field programming capabilities available.

DATA POINT SUMMARY FOR BMS SYSTEM IN IPD & ACADEMIC (AIIMS GUNTUR)								
S.NO.	DESCRIPTION	Qty	DATA PIONT TYPE				DI - Digital Input; AI - Analog Input; DO -Digital Output; AO - Analog Output	
			DI	AI	DO	AO	HVAC/ Electrical/ Plumbing & Other Vendor Scope	BMS Vendor Scope
A	**Chiller Plant**							
	Water Cooled Chillers	**7**						
1	Chiller soft integration						BACnet over MSTP / IP communication from Chiller Plant Manger	BACNet integration to BMS Software. Cabling from Chiller Microprocessor Panel
2	Ambient CO2 level			1				Supply & Installation of Outside CO2 sesnor and cabling to DDC Panel
3	Water temperature at chilled water line			1			Suitable provision to insert the sensor in water line	Supply of immersion water temperature and cabling to DDC
4	Ambient temperature and RH monitoring			2				Supply & Installation of T+Rh sensor and cabling to DDC Panel
5	BTU Meter at Chilled Water Header Line	7					Providing required data through MODBUS RS 485 / MBUS	Integration of Meters with necessary cabling to DDC Panel
6	**Condenser Pumps**	7					BACnet over MSTP / IP communication from Chiller Plant Manger	BACnet over MSTP / IP communication from Chiller Plant Manger
7	**Secondary water Pumps with VFD - Chilled Water**	9					BACnet over MSTP / IP communication from Chiller Plant Manger	BACnet over MSTP / IP communication from Chiller Plant Manger
8	**Secondary water Pumps with VFD - Hot Water**	3					BACnet over MSTP / IP communication from Chiller Plant Manger	BACnet over MSTP / IP communication from Chiller Plant Manger
9	**Primary Pump - Chilled Water**	7						
10	**Primary Pump - Hot Water**	3						
11	**Cooling Towers**	7					BACnet over MSTP / IP communication from Chiller Plant Manger	BACnet over MSTP / IP communication from Chiller Plant Manger
12	**Air Cooled Scroll Type Heat pump**	3					BACnet over MSTP / IP communication from Chiller Plant Manger	BACnet over MSTP / IP communication from Chiller Plant Manger
	Total For AC Plant		**0**	**4**	**0**	**0**		
B	**Air Handling Unit (Floor Mounted)**	**178**						
1	AHU On/ Off Status		178				Suitable High Power Relay contact at AHU Starter Panel	Cabling to DDC Panel
2	AHU On/ Off Command				178		Suitable High Power Relay contact at AHU Starter Panel	Cabling to DDC Panel
3	AHU Trip status		178				All necessary provisions to insert Air DP Switch across the fan	Supply & Installation of Air DP Switch and cabling to DDC Panel
4	AHU Auto/ Manual Status		178				Auto Manual Switch with Potential free contact at AHU Starter Panel	Cabling to DDC Panel
5	AHU filter Choke status		178				All necessary provisions to insert Air DP Switch across filter	Supply & Installation of Air DP Switch and cabling to DDC Panel
6	Return Air Temp + Humidity monitoring			356			All necessary provisions to insert Temperaure and RH Sensor in HVAC Duct	Supply & Installation of Temperaure & RH Sensor and cabling to DDC Panel
7	CHW Valve position modulation					178	Motoroized valve with 0-10V signal	Cabling to DDC Panel
8	Return Air CO2 level monitoring			178			All necessary provisions to insert Sensor in HVAC Duct	Supply & Installation of CO2 Sensor and cabling to DDC Panel
9	Fresh Air damper modulation					178	0-10V signal from damper actuator	Cabling to DDC Panel
10	Suply Air duct static pressure monitoring			178			All necessary provisions to insert Temperaure and RH Sensor in HVAC Duct	Supply & Installation of static pressure Sensor and cabling to DDC Panel
11	Fire status		178					Cabling from FAS control module to DDC
12	VFD Modulation & Feedback			178		178	HVAC Vendor to provide provision to give modulation signal to VFD & take modulation feedback from VFD	Cablinf from VFD to DDC controller
13	VFD soft integration						Providing required data through MODBUS RS 485/ BACNET MSTP	Integration of VFD with necessary cabling to DDC Panel
14	Compulsary Spares		178	178	178	178		
	Total for AHU Units		**1068**	**1068**	**356**	**712**		
C	**Air Handling Unit (Ceiling Suspended)**	**18**						
1	AHU On/ Off Status		18				Suitable High Power Relay contact at AHU Starter Panel	Cabling to DDC Panel
2	AHU On/ Off Command				18		Suitable High Power Relay contact at AHU Starter Panel	Cabling to DDC Panel
3	AHU Trip status		18				All necessary provisions to insert Air DP Switch across the fan	Supply & Installation of Air DP Switch and cabling to DDC Panel
4	AHU Auto/ Manual Status		18				Auto Manual Switch with Potential free contact at AHU Starter Panel	Cabling to DDC Panel
5	AHU filter Choke status		18				All necessary provisions to insert Air DP Switch across filter	Supply & Installation of Air DP Switch and cabling to DDC Panel
6	Return Air Temp + Humidity monitoring			36			All necessary provisions to insert Temperaure and RH Sensor in HVAC Duct	Supply & Installation of Temperaure & RH Sensor and cabling to DDC Panel
7	CHW Valve position modulation					18	Motoroized valve with 0-10V signal	Cabling to DDC Panel
8	Return Air CO2 level monitoring			18			All necessary provisions to insert Sensor in HVAC Duct	Supply & Installation of CO2 Sensor and cabling to DDC Panel
9	Fresh Air damper modulation					18	0-10V signal from damper actuator	Cabling to DDC Panel

10	Suply Air duct static pressure monitoring			18			All necessary provisions to insert Temperaure and RH Sensor in HVAC Duct	Supply & Installation of static pressure Sensor and cabling to DDC Panel
11	Fire status		18					Cabling from FAS control module to DDC
12	VFD Modulation & Feedback			18		18	HVAC Vendor to provide provision to give modulation signal to VFD & take modulation feedback from VFD	Cablinf from VFD to DDC controller
13	VFD soft integration						Providing required data through MODBUS RS 485/ BACNET MSTP	Integration of VFD with necessary cabling to DDC Panel
14	Compulsary Spares		18	18	18	18		
	Total for AHU Units		**108**	**108**	**36**	**72**		
D	**Fan Coil Unit**	**9**						
1	FCU On/ Off Status		9				Suitable High Power Relay contact at AHU Starter Panel	Cabling to DDC Panel
2	FCU On/ Off Command				9		Suitable High Power Relay contact at AHU Starter Panel	Cabling to DDC Panel
3	FCU Trip status		9				All necessary provisions to insert Air DP Switch across the fan	Supply & Installation of Air DP Switch and cabling to DDC Panel
4	FCU Auto/ Manual Status		9				Auto Manual Switch with Potential free contact at AHU Starter Panel	Cabling to DDC Panel
5	CHW Valve position feedback		9				Motoroized valve with 0-10V signal	Cabling to DDC Panel
6	Compulsary Spares		9	9	9	9		
	Total for AHU Units		**45**	**9**	**18**	**9**		
E	**Treated Fresh Air unit (with HRW)**	**37**						
1	TFA supply Fan On/ Off Status		37				All necessary provisions to insert Air DP Switch across the fan	Supply & Installation of Air DP Switch and cabling to DDC Panel
2	TFA supply Fan On/ Off Command				37		Suitable High Power Relay contact at AHU Starter Panel	Cabling to DDC Panel
3	TFA supply Fan Trip status		37				Potential free contact at AHU starter panel for required status	Cabling to DDC Panel
4	TFA exhaust Fan On/ Off Status		37				All necessary provisions to insert Air DP Switch across the fan	Supply & Installation of Air DP Switch and cabling to DDC Panel
5	TFA exhaust Fan On/ Off Command				37		Suitable High Power Relay contact at AHU Starter Panel	Cabling to DDC Panel
6	TFA exhaust Fan Trip status		37				Potential free contact at AHU starter panel for required status	Cabling to DDC Panel
7	CHW Valve position modulation					37	Motoroized valve with 0-10V signal	Cabling to DDC Panel
8	TFA Supply air temperarture monitoring			37			All necessary provisions to insert Temperaure in HVAC Duct	Supply & Installation of Temperaure Sensor and cabling to DDC Panel
9	Heat recovery wheal On/ Off status		37					
10	Heat recovery wheal On/ Off control				37			
11	Compulsary Spares		37	37	37	37		
	Total for Units		**222**	**74**	**148**	**74**		
F	**Treated Fresh Air unit (without HRW)**	**8**						
1	TFA supply Fan On/ Off Status		8				All necessary provisions to insert Air DP Switch across the fan	Supply & Installation of Air DP Switch and cabling to DDC Panel
2	TFA supply Fan On/ Off Command				8		Suitable High Power Relay contact at AHU Starter Panel	Cabling to DDC Panel
3	TFA supply Fan Trip status		8				Potential free contact at AHU starter panel for required status	Cabling to DDC Panel
4	TFA exhaust Fan On/ Off Status		8				All necessary provisions to insert Air DP Switch across the fan	Supply & Installation of Air DP Switch and cabling to DDC Panel
5	TFA exhaust Fan On/ Off Command				8		Suitable High Power Relay contact at AHU Starter Panel	Cabling to DDC Panel
6	TFA exhaust Fan Trip status		8				Potential free contact at AHU starter panel for required status	Cabling to DDC Panel
7	CHW Valve position modulation					8	Motoroized valve with 0-10V signal	Cabling to DDC Panel
8	TFA Supply air temperarture monitoring			8			All necessary provisions to insert Temperaure in HVAC Duct	Supply & Installation of Temperaure Sensor and cabling to DDC Panel
9	Compulsary Spares		8	8	8	8		
	Total for Units		**40**	**16**	**24**	**16**		
G	**Smoke Exhaust/ Fresh Air Ventilation Fans**	**122**						
1	Fan ON/ OFF comand				122		Suitable High Power Relay contact at Starter Panel	Cabling to DDC Panel
2	Fan Run Status		122				All necessary provisions to insert Air DP Switch across the fan	Supply & Installation of Air DP Switch and cabling to DDC Panel
3	Fans Auto Manual Status		122				Auto Manual Switch with Potential free contact at Starter Panel	Cabling to DDC Panel
	Total		**244**	**0**	**122**	**0**		
H	**Toilet Exhaust fans**	**26**						
1	Fan ON/ OFF comand				26		Suitable High Power Relay contact at Starter Panel	Cabling to DDC Panel
2	Fan Run Status		26				All necessary provisions to insert Air DP Switch across the fan	Supply & Installation of Air DP Switch and cabling to DDC Panel
3	Fans Auto Manual Status		26				Auto Manual Switch with Potential free contact at Starter Panel	Cabling to DDC Panel
	Total		**52**	**0**	**26**	**0**		
I	**Staircase/Lifwell/Lobby Pressurisation Fans**	**35**						

1	Fan ON/ OFF comand				35		Suitable High Power Relay contact at Starter Panel	Cabling to DDC Panel
2	Fan Run Status		35				All necessary provisions to insert Air DP Switch across the fan	Supply & Installation of Air DP Switch and cabling to DDC Panel
3	Fans Auto Manual Status		35				Auto Manual Switch with Potential free contact at Starter Panel	Cabling to DDC Panel
	Total		**70**	**0**	**35**	**0**		
J	**Basement/ Plant Room Ventilation Fans**	**48**						
1	Fan ON/ OFF comand				48		Suitable High Power Relay contact at Starter Panel	Cabling to DDC Panel
2	Fan Run Status		48				All necessary provisions to insert Air DP Switch across the fan	Supply & Installation of Air DP Switch and cabling to DDC Panel
3	Fans Auto Manual Status		48				Auto Manual Switch with Potential free contact at Starter Panel	Cabling to DDC Panel
	Total		**96**	**0**	**48**	**0**		
K	**Kitchen Dry Scrubber**	**6**						
1	Scrubber ON/ OFF comand				6		Suitable High Power Relay contact at Starter Panel	Cabling to DDC Panel
2	Scrubber Run Status		6				All necessary provisions to insert Air DP Switch across the fan	Supply & Installation of Air DP Switch and cabling to DDC Panel
3	scrubber filter Status		6				All necessary provisions to insert Air DP Switch across the filter	Supply & Installation of Air DP Switch and cabling to DDC Panel
4	Scrubber Auto Manual Status		6				Auto Manual Switch with Potential free contact at Starter Panel	Cabling to DDC Panel
	Total		**18**	**0**	**6**	**0**		
L	**Kitchen Air Washer Unit**	**10**						
1	Air-Washer ON/ OFF comand				10		Suitable High Power Relay contact at Starter Panel	Cabling to DDC Panel
2	Air Washer Run Status		10				All necessary provisions to insert Air DP Switch across the fan	Supply & Installation of Air DP Switch and cabling to DDC Panel
3	Pump On/Off Command		10				Provision for Potential free contact at Pump Panels	Supply & Installation of Air DP Switch and cabling to DDC Panel
4	Scrubber Auto Manual Status		10				Auto Manual Switch with Potential free contact at Starter Panel	Cabling to DDC Panel
	Total		**30**	**0**	**10**	**0**		
M	**Fire Fighitng**	**20**						
1	FF Pumps at basement trip Status		20				All necessary provisions to insert Water DP Switch in fire pump water line	Supply & Installation of Water DP Switch and cabling to DDC Panel
2	FF Pumps at basement on/ off status		20				Suitable High Power Relay contact at Starter Panel	Cabling to DDC Panel
3	FF pumps at basement on/ off Command- For audit purpose only				20		Suitable High Power Relay contact at Starter Panel	Cabling to DDC Panel
4	FF Pumps at basement Auto/ Manual status		20				Auto Manual Switch with Potential free contact at Starter Panel	Cabling to DDC Panel
5	Hydrant Line Pressure Monitoring			3			All necessary provisions to insert Water Pressure Senros in water line	Supply & Installation of Water DP Switch and cabling to DDC Panel
	Total		**60**	**3**	**20**	**0**		
N	**Water Supply Sytem**	**46**						
1	Water Tank High/ low status		46				All necessary provisions to insert Water Level Switch in fire tank	Supply & Installation of Water Level Switch and cabling to DDC Panel
2	Water Supply pump on/ off status		46				Suitable High Power Relay contact at Starter Panel	Cabling to DDC Panel
3	Water Supply pump on/ off Command				46		Suitable High Power Relay contact at Starter Panel	Cabling to DDC Panel
4	Water Supply pump trip status		46				All necessary provisions to insert Water DP Switch in pump water line	Supply & Installation of Water DP Switch and cabling to DDC Panel
5	Water Supply pump Auto/ Manual status		46				Auto Manual Switch with Potential free contact at Starter Panel	Cabling to DDC Panel
	Total		**184**	**0**	**46**	**0**		
O	**HT panels (11KV & 33KV)**							
1	Main 33KV incommer VCB On/ Off status		4				Potential free contact in VCB for required status	Cabling to DDC Panel

2	Main 33KV incommer VCB Trip status		4				Potential free contact in VCB for required status	Cabling to DDC Panel
3	33KV Bus coupler On/ Off status		2				Potential free contact in bus coupler for required status	Cabling to DDC Panel
4	33KV Bus coupler trip status		2				Potential free contact in bus couper for required status	Cabling to DDC Panel
5	Main 33KV Outgoing VCB On/ Off status		4				Potential free contact in VCB for required status	Cabling to DDC Panel
6	Main 33KV Outgoing VCB Trip status		4				Potential free contact in VCB for required status	Cabling to DDC Panel
7	Main 11KV incommer VCB On/ Off status		14				Potential free contact in VCB for required status	Cabling to DDC Panel
8	Main 11KV incommer VCB Trip status		14				Potential free contact in VCB for required status	Cabling to DDC Panel
9	11KV Bus coupler On/ Off status		3				Potential free contact in bus coupler for required status	Cabling to DDC Panel
10	11KV Bus coupler trip status		3				Potential free contact in bus couper for required status	Cabling to DDC Panel
11	Main 11KV Outgoing VCB On/ Off status		22				Potential free contact in VCB for required status	Cabling to DDC Panel
12	Main 11KV Outgoing VCB Trip status		22				Potential free contact in VCB for required status	Cabling to DDC Panel
	Total		**98**	**0**	**0**	**0**		
P	**DG SETS (6 NOS.)**							
							DG Panel vendor to provide RS 485 BACNET OVER IP/ MODBUS RTU. The electrical vendor to show the parameters on the MODSCAN software before integrating to IBMS. All mapping details & the Master/ slave ID setting in the meter to be done by the DG vendor.	**Integration through Bacnet over IP or Modbus RTU**
1	DG start/ Stop Status		6					Potential free contact from BMS to DG Starter Panel
2	DG AMF Breaker Status		6					Potential free contact from BMS to DG Starter Panel
3	Bulk Storage Tank level Monitoring			2				Flame Proof Level Transmitter
4	DG Oil Day Tank Level			6				Flame Proof Level Transmitter
	Total		**12**	**8**	**0**	**0**		
Q	**IPD LT panels**							
1	Main incommer ACB On/ Off status		3				Potential free contact in ACB for required status	Cabling to DDC Panel
2	Main incommer ACB Trip status		3				Potential free contact in ACB for required status	Cabling to DDC Panel
3	Bus coupler On/ Off status		2				Potential free contact in bus coupler for required status	Cabling to DDC Panel
4	Bus coupler trip status		2				Potential free contact in bus couper for required status	Cabling to DDC Panel
5	Outgoing MCCB On/ Off status		42				Potential free contact in MCCB for required status	Cabling to DDC Panel
6	Outgoing MCCB Triptus		42				Potential free contact in MCCB for required status	Cabling to DDC Panel
	Total		**94**	**0**	**0**	**0**		
	Grand Total							
	Chiller Plant Manager	**300**					**BACNet MSTP/ IP data from chiller plant manager, Chiller manufacturer shall show the data on BDT**	**Integration of CPM through BACNet MSTP/ IP**
	Cooling tower VFD Integration- 7 CTs- 10 points each	**70**					**Modbus MSTP data from CT panel. VFD manufacturer shall show the data on Modscan**	**Integration of VFDs through Modbus Protocol/ Bacnet**
	AHU/ TFA VFD integration- 241 Nos- 9 points each	**2169**					**Modbus MSTP data from VFD, AHU manufacturer shall show the data on Modscan**	**Integration of VFDs through Modbus RS485 (MSTP)**
	Lifts and escalators- 46 Nos.- 15 points each	**690**					**Modbus MSTP data from lift panel, Lift manufacturer shall show the data on Modscan**	**Integration of VFDs through Modbus RS485 (MSTP)**
	UPS- 8 Nos- 40 points per UPS	**320**					**Modbus MSTP data from UPS, UPS manufacturer shall show the data on Modscan**	**Integration of VFDs through Modbus RS485 (MSTP)**
	Energy meters- 50 Numbers- 10 points per meter	**500**					**Modbus MSTP data from meters, Meter manufacturer shall show the data on Modscan**	**Integration of VFDs through Modbus RS485 (MSTP)**
	VAV Boxes soft integration- 1174 VAVs- 5 points per VAV	**5870**					**Modbus MSTP data from VAV Commandler, VAV Commandler manufacturer shall show the data on Modscan**	**Integration of VAV through Modbus RS485 (MSTP)**
	VRV ODU Integration -12 nos. - 10 points per ODU	**120**					**BACNet MSTP/ IP data from VRF main controller, VRF manufacturer shall share mapping details**	**Integration of VRF through BACNet/IP**
	Fire Alarm System						**FAS vendor shall provide the complete FAS data on Modnus/ BACNet/ IOPC**	**Integration of FAS through Modbus/ Bacnet/ OPC Protocols**
	Block Total	**10039**	**2441**	**1290**	**895**	**883**		

DATA POINT SUMMARY FOR BMS SYSTEM FOR AAYUSH (AIIMS GUNTUR)								
S.NO.	DESCRIPTION	Qty	DATA PIONT TYPE				DI - Digital Input; AI - Analog Input; DO -Digital Output; AO - Analog Output	
			DI	AI	DO	AO	HVAC/ Electrical/ Plumbing & Other Vendor Scope	BMS Vendor Scope
A	**Air Handling Unit (Floor Mounted)**	**7**						
1	AHU On/ Off Status		7				Suitable High Power Relay contact at AHU Starter Panel	Cabling to DDC Panel
2	AHU On/ Off Command				7		Suitable High Power Relay contact at AHU Starter Panel	Cabling to DDC Panel
3	AHU Trip status		7				All necessary provisions to insert Air DP Switch across the fan	Supply & Installation of Air DP Switch and cabling to DDC Panel
4	AHU Auto/ Manual Status		7				Auto Manual Switch with Potential free contact at AHU Starter Panel	Cabling to DDC Panel
5	AHU filter Choke status		7				All necessary provisions to insert Air DP Switch across filter	Supply & Installation of Air DP Switch and cabling to DDC Panel
6	Return Air Temp + Humidity monitoring			14			All necessary provisions to insert Temperaure and RH Sensor in HVAC Duct	Supply & Installation of Temperaure & RH Sensor and cabling to DDC Panel
7	CHW Valve position modulation					7	Motoroized valve with 0-10V signal	Cabling to DDC Panel
8	Return Air CO2 level monitoring			7			All necessary provisions to insert Sensor in HVAC Duct	Supply & Installation of CO2 Sensor and cabling to DDC Panel
9	Fresh Air damper modulation					7	0-10V signal from damper actuator	Cabling to DDC Panel
10	Suply Air duct static pressure monitoring			7			All necessary provisions to insert Temperaure and RH Sensor in HVAC Duct	Supply & Installation of static pressure Sensor and cabling to DDC Panel
11	Fire status		7					Cabling from FAS control module to DDC
12	VFD Modulation & Feedback			7		7	HVAC Vendor to provide provision to give modulation signal to VFD & take modulation feedback from VFD	Cablinf from VFD to DDC controller
13	VFD soft integration						Providing required data through MODBUS RS 485/ BACNET MSTP	Integration of VFD with necessary cabling to DDC Panel
14	Compulsary Spares		7	7	7	7		
	Total for AHU Units		**42**	**42**	**14**	**28**		
B	**Fan Coil Unit**	**26**						
1	FCU On/ Off Status		26				Suitable High Power Relay contact at AHU Starter Panel	Cabling to DDC Panel
2	FCU On/ Off Command				26		Suitable High Power Relay contact at AHU Starter Panel	Cabling to DDC Panel
3	FCU Trip status		26				All necessary provisions to insert Air DP Switch across the fan	Supply & Installation of Air DP Switch and cabling to DDC Panel
4	FCU Auto/ Manual Status		26				Auto Manual Switch with Potential free contact at AHU Starter Panel	Cabling to DDC Panel
5	CHW Valve position feedback		26				Motoroized valve with 0-10V signal	Cabling to DDC Panel
6	Compulsary Spares		9	9	9	9		
	Total for AHU Units		**113**	**9**	**35**	**9**		
C	**Treated Fresh Air unit (without HRW)**	**1**						
1	TFA supply Fan On/ Off Status		1				All necessary provisions to insert Air DP Switch across the fan	Supply & Installation of Air DP Switch and cabling to DDC Panel
2	TFA supply Fan On/ Off Command				1		Suitable High Power Relay contact at AHU Starter Panel	Cabling to DDC Panel
3	TFA supply Fan Trip status		1				Potential free contact at AHU starter panel for required status	Cabling to DDC Panel
4	TFA exhaust Fan On/ Off Status		1				All necessary provisions to insert Air DP Switch across the fan	Supply & Installation of Air DP Switch and cabling to DDC Panel
5	TFA exhaust Fan On/ Off Command				1		Suitable High Power Relay contact at AHU Starter Panel	Cabling to DDC Panel
6	TFA exhaust Fan Trip status		1				Potential free contact at AHU starter panel for required status	Cabling to DDC Panel
7	CHW Valve position modulation					1	Motoroized valve with 0-10V signal	Cabling to DDC Panel
8	TFA Supply air temperarture monitoring			1			All necessary provisions to insert Temperaure in HVAC Duct	Supply & Installation of Temperaure Sensor and cabling to DDC Panel
9	Compulsary Spares		8	8	8	8		
	Total for Units		**12**	**9**	**10**	**9**		
D	**Smoke Exhaust/ Fresh Air Ventilation Fans**	**4**						
1	Fan ON/ OFF comand				4		Suitable High Power Relay contact at Starter Panel	Cabling to DDC Panel
2	Fan Run Status		4				All necessary provisions to insert Air DP Switch across the fan	Supply & Installation of Air DP Switch and cabling to DDC Panel

3	Fans Auto Manual Status		4				Auto Manual Switch with Potential free contact at Starter Panel	Cabling to DDC Panel
	Total		**8**	**0**	**4**	**0**		
E	**Toilet Exhaust fans**	**2**						
1	Fan ON/ OFF comand				2		Suitable High Power Relay contact at Starter Panel	Cabling to DDC Panel
2	Fan Run Status		2				All necessary provisions to insert Air DP Switch across the fan	Supply & Installation of Air DP Switch and cabling to DDC Panel
3	Fans Auto Manual Status		2				Auto Manual Switch with Potential free contact at Starter Panel	Cabling to DDC Panel
	Total		**4**	**0**	**2**	**0**		
F	**Staircase/Lifwell/Lobby Pressurisation Fans**	**4**						
1	Fan ON/ OFF comand				4		Suitable High Power Relay contact at Starter Panel	Cabling to DDC Panel
2	Fan Run Status		4				All necessary provisions to insert Air DP Switch across the fan	Supply & Installation of Air DP Switch and cabling to DDC Panel
3	Fans Auto Manual Status		4				Auto Manual Switch with Potential free contact at Starter Panel	Cabling to DDC Panel
	Total		**8**	**0**	**4**	**0**		
	Grand Total							
	AHU/ TFA VFD integration- 8 Nos- 9 points each	**72**					**Modbus MSTP data from VFD, AHU manufacturer shall show the data on Modscan**	**Integration of VFDs through Modbus RS485 (MSTP)**
	Lifts and escalators- 4 Nos.- 15 points each	**60**					**Modbus MSTP data from lift panel, Lift manufacturer shall show the data on Modscan**	**Integration of VFDs through Modbus RS485 (MSTP)**
	UPS- 1 Nos- 40 points per UPS	**40**					**Modbus MSTP data from UPS, UPS manufacturer shall show the data on Modscan**	**Integration of VFDs through Modbus RS485 (MSTP)**
	Energy meters- 12 Numbers- 10 points per meter	**120**					**Modbus MSTP data from meters, Meter manufacturer shall show the data on Modscan**	**Integration of VFDs through Modbus RS485 (MSTP)**
	VRV ODU Integration -2 nos. - 10 points per ODU	**28**					**BACNet MSTP/ IP data from VRF main controller, VRF manufacturer shall share mapping details**	**Integration of VRF through BACNet/IP**
	Fire Alarm System						**FAS vendor shall provide the complete FAS data on Modnus/ BACNet/ IOPC**	**Integration of FAS through Modbus/ Bacnet/ OPC Protocols**
	Block Total	**320**	**187**	**60**	**69**	**46**		

LIST OF APPROVED MAKES FOR ELCTRICAL SYSTEM

Contractor shall use the materials of approved make as indicated below unless specified in BOQ or as approved by the HSCC engineer incharge. The contractor shall ensure the correct selection of the approved make meeting the specifications and application duties. Before placing order for procurement, the sample of approved make shall be got verified for its suitability to the specification and application duty. However, HSCC engineer incharge reserves the right to opt for the best preferred listed make. The contractor shall quote the rates for the material and equipment as per the list of approved makes. In the event of the contractor wants to use alternate makes other than those stipulated for non availability, monopolistic attitude with proof, the contractor can send a proposal after ensuring that what he proposes at the least meets both the quality and safety standard of the stipulated makes, and the financial benefit, if any, that will accur to the client. He shall also stand full guarantee to his alternate proposal. The alternate makes can be used only after an approval accorded by the client/HSCC., whose decision will be final in this matter.

Note- Approved Main LT Panel manufacture can use their Own Manufactured items for fabrication of panels. Authorized panel builders will not be accepted.

S.No.	ITEM	MAKE
1	HT VCB Panel Board/ RMU	Siemens/L&T/ABB/Schneider
2	Transformer	ABB/GE/ Schneider/Alstom
3	Main LT Panel/ APFC panels / Active Harmonic Filter (AHF)	Siemens/ L&T/ABB/Schneider
4	Additional make for APFC Panel/ AHF	EPCOS, Ducati
5	Synchronization Panel/AMF Panel	OEM of the DG set or above panel manufacturer as mentioned against s.no.-3
6	Diesel Engine:	Cummins/ Caterpillar/MTU/ Perkins- Sterling
7	Alternator:	Stamford/AVK/ Leroysomer/ KEC
8	Fastener	Hilti/ Fisher or equivalent as approved by HSCC
9	Anti-vibration mounting:	Dunlop, Gerb, resistoflex
10	Bus Duct/Rising main	L&T/ABB/Siemens/Schneider/GE/ Legrand

- **Equivalent makes can be added with price adjustment with the prior approval of Engineer-in-charge**

11.	Battery:	Panasonic/Hitachi/Cummins/Exide
12.	MV panels/Fire panel/AHU Panel	Tricolite/Adlec./Sterling &Wilson / Control & Switchgear/Nitya Electro Control Pvt. Ltd./Zeta
13.	ACB	L &T 'U' Power(Omega)/ Siemens 3WL/ ABB/ Legrand(DMX)/ Schneider (NW- Master Pact)
14.	Moulded Case Circuit Breaker	L &T – (D sine/DL) / Siemens-VA/ ABB-TMA/ Schneider – (NSX/NS/CVS) /Legrand-DPX
15.	Power/auxiliary Contactors, timers, Relay, starters	ABB/ Schneider/ L&T/ Siemens
16.	AMF Relay	wood ward
17.	SFU with HRC	L&T/ Siemens/ ABB/ Schneider/GE
18.	Change over switches/Isolators	Schneider / Siemens/ABB/GE/L&T
19.	Instruments (Analog & Digital)	L&T/ AE/ Siemens/ Schneider/ABB
20.	Timers	Legrand/ L&T/ Siemens/ ABB
21.	Cast resin current Transformers:	AE/L&T
22.	Selector Switches:	L&T /KAYCEE/ Siemens
23.	Push button, Indicating Lamps LED:	L&T /Siemens/Schinder
24.	Auto manual changeover switches (3Way)	Kaycee/L&T/ Schnieder/Siemens

- **Equivalent makes can be added with price adjustment with the prior approval of Engineer-in-charge**

25	MCB distribution Boards	L &T/Hager/Legrand/ Siemens/ Schneider/GE / Philips
26	RCCB/MCB	L & T / Legrand-DX3/ Siemens / Schenider –Acti 9/GE/ Hager/Philips
27	HT/LT- XLPE cables	CCI/Universal/Finolex
28	Copper Control cable	CCI/ Universal/Finolex
29	Compression Glands & Lugs	Comet/ Dowells
30	PVC Tape	Steel Grip
31	Cable Jointing kit	Raychem / 3M
32.	Cable Trays/ Raceways	OBO/ Legrand/ Cooper
33	Terminal Strips	Elmex/ Connectwell/ Technoplast
34	LED light fitting & Fixture	Philips / GE/ Crompton Greaves
35	MS conduit	BEC/ AKG/ Steel Kraft

- **Equivalent makes can be added with price adjustment with the prior approval of Engineer-in-charge**

36	PVC conduit	Supreme/Prince/Finolex/AKG/BEC
37	Conduit accessories MS & PVC	As approved by HSCC
38	Solar Power system	TATA Power Solar, CEL, BHEL, BEL
39	Copper conductor PVC insulated wires, Co-axial , Telephone wires & cables	L&T/ Batra Henlay/ Bonton/
40	Additional make for telephone wire & cable	Delton
41	Modular Switches & sockets Outlets	Legrand-Myrius or Anti bacterial/L&T Oris/ Schneider -Livia / Philips -Sleek
42	Metal clad Socket outlets With boxes	L & T /Hager/ Siemens/ Schneider/ ABB/Legrand /HPL
43	Lighting protection	Erico/Galaxy electrode /Earth plus
44	UPS system	Schneider- MG , APC/ Etone Power ware/ Emerson
45	High Mast poles	Crompton Greaves /Phillips
46	Ceiling fans	Crompton Greaves/ Orient/ Usha
47	PC with CPU and monitor etc	HP/ Compaq/Del/IBM
48	Auto Transfer switch	Cummins/Emerson-Asco/GE/ Russelectric
49	Public address system	Bosch/ Bose/ Honey well /Harman
50	CCTV camera	Pelco /Bosch/Sony/Axis
51	LCD/LED Monitor	Sony/Panasonic/Samsung/ Toshiba
52	Fire Detection System Addressable	Honeywell-Notifier/Edward/Bosch/ Siemens

- **Equivalent makes can be added with price adjustment with the prior approval of Engineer-in-charge**

53	FDA Conventional	Honeywell/Bosch or equivalent as approved by HSCC
54	Portable fire extinguisher	Minimax/Ceasefire/
55	EPABX system	Avaya/ Siemens-unify/Alcatel/Cisco
56	Nurse Call bell system	Category A: Honeywell/Schreak/ Rauland
57	Capacitor	Epcos, Schenider, L&T, Ducati
58	APFC Relay	Epcos, L&T, Biluk, Ducati, Schneider
59	Occupancy Sensor	Philips/ Honeywell/ Schneider/Lutron/Legrand
60	Lifts/ Dumb Waiters/Escalators	Otis /Kone/ Mitsubishi/ Scheindler
61	BMS, field devices etc	Honeywell-Trend/L&T-Atmos/Siemens/Schneider
62	Lighting Control	Lutron/ Philips/ ABB/ Schneider/ Legrand
63	Chemical Earthing	OBO Bettermann / Erico/Furse / Ingesco/
64	Access Control System	Honeywell-Pro-3000/Schneider/Lenel/Cardex
65	Boom barrier	Magnetic/ Somfy/ RIB/FAAC
66	CAT 6 UTP, CAT 6A UTP/STP, Optical Fibre-cable	Molex/Systimax/Panduit

- **Equivalent makes can be added with price adjustment with the prior approval of Engineer-in-charge**

END OF TECHNICAL SPECIFICATION