SPECIAL CONDITIONS OF CONTRACT FOR ELECTRICAL WORKS

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. All conduit work including junction boxes, outlet boxes, wiring & earthing for lighting & power.
b. All conduit work including junction boxes, outlet boxes & wiring for LV systems such as voice, data, fire alarm, paging, CCTV, Access control & MATV etc.
c. Switches, plug sockets, cover plates and wiring accessories.
d. Emergency lighting, wiring, Inverter/UPS.
e. Substation, HT Switchgear and HT Cabling.
f. Mains and sub-mains between various distribution boards, cables, submain wiring, cable trays, Rising Mains & Bus Ducts.
g. Distribution Boards, Panels, meter boards & final DB's.
h. Earthing system.
i. Lighting Fixtures and Fans.
j. Lightning Arrestor System
k. External lighting, cabling, lighting fixtures and poles.
l. Preparation of "Shop drawings" .
m. Training of owner's staff/representative.
n. Preparation of "As Built Drawings & Documents".

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, International Electricity Rules and Regulations, 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

BIS stands for Bureau of Indian Standards

NEC stands for National Electrical Code

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 can not 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 every thing 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 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 Locking 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 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 the 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 labor 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.

INSTALLATION OF D. G. SETS

1.0 GENERAL:

1.1 The preliminary drawings shall be provided by the CLIENT to the contractor and based on these drawings contractor shall prepared and submit detailed and working drawing to CLIENT. After getting the approval by CLIENT duly signed and stamped, the work shall be carried out in the accordance with the approved drawings and design. The contractor shall not take cognizance of any drawings, designs, specifications etc. not bearing CLIENT representative's signature and stamp. Similarly, the contactor shall not take cognizance of instructions given by any other authority except the instructions given by the Engineer-in-charge in writing.

1.2 The work shall be executed and measured as per metric dimensions given in the Schedule of Quantities/ drawings etc.

1.3 The Contractor shall acquaint himself fully with the partial provisions for supports that may be available in the structure and utilize them to the extent possible.

In any case the contractor shall provide all the supports regardless of provisions that they have been already made. Nothing extra shall be payable for situations where insert plates (for supports) are not available or are not useful.

1.4 MEASUREMENTS

All measurements shall be taken in accordance with relevant BSI/ NBS codes unless otherwise specified.

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.

o. 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 certificate 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. The contractor shall be responsible for getting the electrical installation inspected and approved by the local authorities concerned.

SPECIAL CONDITIONS OF CONTRACT FOR HVAC WORKS

1.1 GENERAL INFORMATION

The Special / Particular Instruction and Conditions of Contract as described in this document are intended to amplify the General conditions of Contract and shall be read in conjunction with specifications of work, drawings and all other documents forming part of this Contract wherever the context so requires. The following clauses shall be considered as an extension and not in limitation of obligation of the Contractor.

All expenses incurred by the CONTRACTOR in connection with obtaining information for submitting this tender including his visits to the site or efforts in compiling the tender shall be borne by the CONTRACTOR and no claims for reimbursement shall be entertained.

Notwithstanding the sub-division of the documents into separate sections and volumes every part of each shall be deemed to be supplementary to and complementary of every other part and shall be read with and into the CONTRACT.

Wherever it is mentioned in the specification, that the CONTRACTOR shall perform certain work or provide certain facilities, it is understood that the CONTRACTOR shall do so at his own cost.

1.2 OBLIGATION OF CONTRACTOR

The obligation of Contractor in fulfilment of HVAC works are stated below:

- Procurement, fabrication and supply
- Inspection and testing
- Expediting and co-ordinating with other agencies
- Scheduling and Monitoring

- Training the Client's representative in the Operation & Maintenance of the Plant
- Erection, checking and testing
- Commissioning
- Carrying out performance tests to meet the specification requirement and to the full satisfaction of EMPLOYER
- Providing Guarantee
- Maintenance during Guarantee/Defects Liability period
- Final documentation

Checking up the equipment and other materials to ensure that the same are as per the specifications laid down in description of work and drawings and also to make sure that they are in proper condition to be taken up for erection.

Drawing up a detailed time schedule and organise the erection work in conformity with the time schedule.

Arranging for the procurement and ensuring availability at the site at the required time of all the erection tools, necessary tackle, required for the erection work such as cranes, air compressor, welding sets, oxy-acetylene cutters, electric and pneumatic drills, steel wedges for levelling and grouting, scaffolding gay wire testing and cleaning equipment and all other construction equipment necessary for proper erection.

Arranging for procurement and ensuring availability at site at the time of all consumable construct materials for erection work such as welding electrodes, oxygen, acetylene and other welding gases, greases, petrol, cotton waste and all temporary fastening such as tack bolts clips, cleats and other materials, chemicals for cleaning and such other materials as may be needed to execute the handling and erection works.

Engaging and allotting an adequate number of engineers, erectors of all the required categories (Supervisory, skilled and unskilled labour) for carrying out different items at different stages of the erection work.

Assembling and installing of all items of machinery / equipment at their proper places at the plant site. The erection work will cover necessary operations such as, handling, sorting, stacking, unpacking, cleaning, assembling, bottling welding riveting, erecting, site fabrication, instrument cable laying and jointing, earthing, erecting, site fabrication, instrument cable laying and jointing, earthing, treatment for underground pipe protection, painting, thermal insulation and manual / mechanical / chemical cleaning, testing and other operations, provision of inserts, embedded plates in walls / roof / floor for erection of ducting, piping etc. Installation of all instruments – measuring and controlling of the plant. All control wiring also forms part of erection work.

Checking up of each individual items of plant equipment and also each pipeline, to ensure that the erection of these items has been properly carried out in conformity with the technical specification.

After all the installation and assembly work is completed the entire plant assembly including the pipe lines shall be checked up, by proper tests applicable to ensure that individual items of equipment, including pipe line have been properly installed.

Machines like compressors, pumps shall be checked up by actual working to satisfy that their alignment has been properly made and there are no mechanical faults.

Pipe lines shall be checked up by hydraulic tests to make sure that all valves, flanges etc., have been properly fitted up to that there are no leakages or wrong connection of interconnecting valves, pipes etc. Similarly, all ductwork shall be tested to ensure that air leakages rates are within the limits prescribed in the specification.

Instruments shall be checked up individually to make sure that they are in proper working order. The testing shall be in accordance with accepted International Standards. All instruments used for testing and measurements shall be calibrated instruments acceptable to National level standards.

The performance of the aforesaid services should confirm strictly to the ENGINEER'S technical specification, which forms an integral part of 'THIS CONTRACT'.

It is only after the entire plant assembly has been thoroughly checked up on the lines indicated above and found satisfactory that erection work shall deemed to be completed and the plant considered READY FOR COMMISSIONING.

Plant and equipment details shall also be prominently displayed in engraved plastic nameplates.

The Contractor shall if called upon, also furnish necessary electrical wiring diagram to meet the requirements of the Electricity authorities.

1.3 QUALITY ASSURANCE REQUIREMENTS

GENERAL

Quality Assurance (QA) requirements form an integral part of the contract and all contractors are required to comply.

SCOPE

The scope of QA requirements is as follows:

a) Preparation of a Quality Assurance Plan by the Contractor, which is referred to as "CONTRACTOR'S QUALITY PLAN" or CQP.

b) Performance of:
- Quality Assurance (QA) and
- Quality Control (QC) activities at site

c) Documentation of the above

1.4 TENDER DRAWINGS

The Drawings issued with this Specification are for guidance of the CONTRACTOR and show the approximate positions of all items of equipment, etc. The actual and final position of all items of equipment shall be determined at site and approved by the Consulting ENGINEER. CONTRACTOR is to ensure that their proposal will meet with all the current rules and regulations of the relevant authorities in India.

1.5 SHOP DRAWINGS

a) All Shop Drawings shall be on Standard A0/A1 size paper depending upon the content and details of the drawing.

b) Before any work is put in hand, the Contractor shall submit two (2) sets of dimensioned Drawings showing all details of the equipment, piping, wiring and materials etc. to be used, to the Consulting ENGINEER for review. The Contractor shall not commence final connection works until the Drawings are reviewed by the Consulting ENGINEER.

c) Review of Drawings by the Consulting ENGINEER does not exonerate the Contractor from any responsibility under the Contract terms and conditions.

d) The detailed Shop Drawings, prepared at a minimum scale of 1:100, plus necessary detail plans and cross sections at a scale of 1:50, showing complete detail of each item of specially fabricated equipment shall be submitted to the Consulting ENGINEER for his review before proceeding with fabrication. These Drawings shall be based upon the floor plans and the following specifications. These Drawings shall include accurately dimensioned details and locations of any special wall openings that are required where items of equipment extend through walls.

e) If early review is required, the Contractor shall advise the Consulting ENGINEER to this effect when submitting the drawings.

f) The Contractor shall forward eight (4) sets of the reviewed shop drawings to the Consulting engineer for distribution to interested parties.

1.6 WORKING DRAWINGS

The Contractor shall at all times maintain on site, in good order and condition, a complete set of all Drawings and Documents necessary for the proper execution and checking of the Works. These Drawings and Documents shall be made available on request to the Consulting ENGINEER or other authorised persons on site. Any amendment shall be indicated on the Drawing, dated and signed by the Authorised person in charge, with reasons stated if possible.

1.7 AS-INSTALLED DRAWINGS

a) The Contractor shall prepare two (2) sets of paper prints of the As-Installed Drawings, diagrams and schedules as in the opinion of the Consulting engineers, shows an accurate record of the work as installed by the Contractor and submit to the Consulting ENGINEER for approval. When approved, the Contractor shall submit three (3) sets of paper prints, one (1)

set of sepia and one (1) CD ROM of the approved As-Installed Drawings for reference and record by the Consulting ENGINEER.

b) Such records shall include the preparation of properly dimensioned drawings showing the following:

i) General arrangement of all services
ii) Cable routes, types of fixings, layout, support and other particulars;
iii) The detailed layout of all equipment, plant chambers, etc;
iv) Conduit runs, pipe runs, duct work, etc.
v) A system diagram giving means of identification, circuit labelling and mounting level of equipment, etc., provided under the Sub-Contract;
vi) Schedules of all equipment installed.

c) All Drawings submitted by the Contractor shall have in the bottom right-hand corner in addition to the Contractor's name, title, scale, date and drawing number, the title of the project and subject of the drawings.

d) The retention sum or final payment will not be released until all such drawings and records have been received and approved by the Consulting ENGINEER.

e) One copy of the schematic drawing, isometric or layout drawing showing all equipment, controls, connections, etc. shall be framed and hung in the relevant Plant Room or location as directed by the Consulting ENGINEER.

1.8 TESTING AND COMMISSIONING

a) GENERAL

Testing shall mean providing that all of the systems efficiently meet the performance specified while in operation. The systems shall be tested in the presence of the Consulting ENGINEER who requires at least two full working days prior notice to enable him to attend.

The Contractor shall arrange for representatives of any of his own sub-Contractor to be in attendance.

It shall be the responsibility of the Contractor to supply all necessary testing equipment including pitot tube and manometer, anemometer, newly calibrated pressure gauge, etc. Provision of all testing equipment and the appropriately skilled labour shall have been included in the Tender Price.

Should anyone of the tests reveal a fault, the Consulting ENGINEER will order that the fault be corrected and re-tested prior to acceptance. All fees connected with testing of equipment payable by Contractor to any of the relevant Government Authority shall be borne by the Contractor.

b) COMMISSIONING TEST

i) The complete installation or any part thereof shall be tested, both before and after being commissioned to check the performance in operation. All fees connected with testing of

equipment payable by the Contractor to any of the relevant Government Authority or expert from the Supplier shall have been included in the Tender Sum.

ii) The contractor shall be represented by a competent person approved by the Consulting ENGINEER during the whole of the period required for the tests.

iii) All materials and equipment supplied or erected under this Contract which fail the tests shall be replaced or rectified at once by the Contractor without cost to the EMPLOYER.

iv) The Contractor shall supply all necessary instruments, apparatus, connections, skilled and unskilled labour required for the tests to be conducted in the presence of the Consulting ENGINEERS, make accurate records of all tests carried out and furnish the Consulting ENGINEERS with four (4) COPIES OF THE Test Certificates and Schedule of Test Results in approved form.

v) The Contractor shall prepare a detailed and comprehensive checklist for use during commissioning and testing. The Contractor shall submit to the Consulting ENGINEER his proposed check list for approval as follow:

1) Ensure that all items that should be checked are included.
2) Produce a permanent record of the commissioning checks carried out.
3) Accordingly, the checklist must be built from information contained in the Specification, from Suppliers, SUB-Contractor's and Contractor's installation and commissioning similar equipment and systems.
4) The detail of the checklist must be such that it can be completed with a reading or a tick, which means that every device listed, has been checked.

1.9 OPERATING MANUALS

The Contractor shall prepare three (3) copies of an operating manual, in a stiff-covered ring binder two (2) for the EMPLOYER and one (1) for the Consulting ENGINEER, describing the operation and maintenance of the whole system and including: -

a) Operating instruction for all equipment
b) Catalogues for all equipment.
c) List of spares recommended;
d) Schedule of Recommended Maintenance.

Practical completion will be certified after the receipt of the above operating manual by the Consulting ENGINEER.

1.10 IDENTIFICATION AND LABELLING

Parts of the Works shall be properly labelled and identified. The contractor shall carry out the following work: -

i) Machine engraved traffolyte nameplates shall be provided to identify majority of equipment. Similar labels will indicate the function of ancillary equipment such as gauges, control valves, switches, indicating lights, push buttons, relays and other indicating devices.

ii) Lettering shall be black on white background. Nameplates for major items of equipment shall be engraved in lettering of at least 6 mm. Labels identifying ancillary equipment shall be engraved in lettering of at least 3 mm.

iii) Identification lettering shall be applied to all pipe work and to all conduit at the following spacing: -

1) For all concealed runs in walls or ceiling spaces, every 5 metres but at least once.
2) For exposed runs, every 10 metres but at least once for each exposed section.

The identification shall consist of stencilled painted black lettering 25 mm high naming the services.

1.11 PLANT OPERATION

The EMPLOYER shall have free and unrestricted use of the Contract Works or any part thereof which the Consulting ENGINEER may deem suitable without any interference whatsoever from the Contractor and such use by the EMPLOYER shall not relieve the Contractor of any liabilities or obligations in regard to the Contract.

1.12 TESTING

Routine and type for various items of equipment shall be performed at the SUB-Contractor's works and test certificates shall be furnished. The EMPLOYER or his authorised representative reserves the right to be present during the tests.

After notification to the EMPLOYER that the installation has been completed, the Contractor shall make under the direction of EMPLOYER such tests and inspections as have been specified or as the EMPLOYER shall consider necessary to determine whether or not the full intent of the specifications have been fulfilled and whether further tests shall be considered necessary. The Contractor shall bear all the expenses thereof.

The Contractor shall operate, test and adjust all air-conditioning, ventilation and exhaust system units, fan motors, all air handling appliances provided in connection with the installation and shall make all necessary adjustments and corrections thereof including the adjustments of all regulating dampers. A carefully detailed record of the results of these adjustments shall be furnished to and be subject to the approval of the EMPLOYER.

1.13 PERFORMANCE TEST

A performance test by keeping the plant running for a period of 72 hrs. shall be carried out in peak summer, peak monsoon and peak winter periods. During the tests all necessary readings shall be taken hourly. From the readings so taken, the Contractor shall also establish the plant capacity. The computed results shall tally with the specified capacities furnished with Tender.

The contractor shall install in the system temperature probes, flow meters, pressure gauges etc., to verify the capacity of the various equipment.

All the test equipment instruments, labour, operating personnel, oil and refrigerant required for these tests shall be furnished by the Contractor at his own cost.

If the test do not show satisfactory result, the Contractor shall at his own cost, rectify / replace and defective installation or part thereof as directed by the EMPLOYER within two months. The decision of the EMPLOYER shall be final and binding in this respect. Only after all these tests are satisfactorily completed and the defects found during these are rectified, the plant will be finally accepted.

1.14 TESTING GUARANTEE

All equipment and space conditions shall be tested after carrying out necessary adjustments and balancing to establish the equipment ratings and indoor space conditions. At least four sets of readings shall be taken daily for each item tested and submitted in the form shown separately. Instruments required for testing shall be furnished by the Contractor.

All equipment shall be guaranteed for the specified ratings with a tolerance of 0% on the minus (negative) side.

All equipments and the entire installation shall be guaranteed against defective materials and workmanship for a period of 12(twelve) months from the date the equipment and installation are handed over.

1.15 REPORTS

Provide 3 copies of the complete balancing and testing reports to the EMPLOYER / Consulting engineer. Report shall be neatly typed and bound suitable for a permanent record. Report forms shall contain complete test data and equipment data as specified.

1.16 TRAINING

Upon commissioning and final handover of the installation, the Contractor shall submit 3 copies of operating instructions, maintenance and service manuals, part lists and all final drawings and diagrams, indexed and bound together in hard cover ring binder.

The Contractor shall conduct a training programme for designated Employer's personnel. These courses shall be carried out during normal office hours. The date of commencement of training shall be mutually agreed upon and, in any case, shall be within two weeks of handover of installation.

The training programme shall cover all operating and maintenance aspects of the system, inclusive of detailed explanation and demonstration of each and every piece of equipment and an overview of the system network.

The training programme shall consist of both handouts and classroom training at the job site or at location agreed upon by the EMPLOYER.

All instruction manuals, tools, transportation, etc. association with the training programme shall be provided by the Contractor. Such cost shall be deemed to have been included in the CONTRACTOR programme.

1.18 GUARANTEE

The Contractor shall guarantee the inside conditions as stipulated elsewhere. In addition, the Contractor shall also guarantee that all equipment shall be free from any defect due to the defective materials and bad workmanship and that the equipment shall operate satisfactorily and the performance and efficiencies of the equipment shall be not less than the guarantee values.

The guarantee shall be valid for a period of 12 months after taking over and any parts found defective shall be replaced free of all costs by Contractor. The services of successful Contractor's personnel if requisitioned by the EMPLOYER during this defects liability period for such work shall be made available free of any cost.

The Contractor shall without any extra cost carry out for a period of 12 (twelve) months after the installation is taken over, all routine and special maintenance of the plant and attend to the defects that may arise in the operations of the plant.

Maintenance will consist of monthly maintenance and necessary adjustment and lubrication of the equipment by the Contractor's employee under competent direction and supervision. In addition to the monthly maintenance, special examination between regular intervals and emergency minor adjustment, call back services should be provided during the guarantee period.

Parts that become necessary due to normal wear and tear during the guarantee period will have to be replaced free of cost.

In case of any defect or malfunctions of the equipment during the period of maintenance, immediate attention must be ensured without claim to any extra amount, charges or compensation.
All the maintenance work will be performed during regular hours of regular working days. However, the works in condenser coil and cleaning of cooling coils etc., should be carried out only during the holidays with prior permission from the EMPLOYER.

One month before the end of the defect's liability period, the Contractor shall notify the EMPLOYER of the required inspections for all equipment and facilities including specific energy consumption.

1.19 MAINTENANCE IN WARRANTY PERIOD

The CONTRACTOR shall furnish warranty for the entire system for a defect liability period (DLP) of twelve (12) months after the final official hand over date of the installation duly approved by the consultants and project managers. This period shall include maintenance replacement of parts, regular periodic visit by qualified personnel of the CONTRACTOR and attending to emergency call at short notice.

1.20 CONCLUSION OF 12-MONTH WARRANTY PERIOD

Just before the expiry of the warranty period of the Contract, the Contractor shall carry out a complete system operability test on all the systems or sub-systems as called for in the Contract.

The purpose of the test is to verify that the performance of all the systems of sub-systems in the Contract is in accordance to the specifications.

All tests shall be carried out in the presence of the EMPLOYER or his representative.

The warranty period is deemed to be over if the EMPLOYER or his representative is completely satisfied with the system performance during the test.

1.21 ANNUAL MAINTENANCE CONTRACT

The CONTRACTOR shall quote separately for comprehensive and all-inclusive (labour and material and everything) Annual Maintenance Contract for full five years period after the Defect Liability Period (DLP). The CONTRACTOR shall bear the full responsibility for all kinds of maintenance which includes periodic maintenance as well as attending to all breakdown and emergency calls at short notice whenever called. During this five-year period the scope of annual maintenance contract includes repair and replacement of any or all parts as required. Besides, the replenishment of all consumables shall also to be included in the scope of annual maintenance contract.

The CONTRACTOR shall furnish the list of recommended spares along with quantity and unit price schedule to the EMPLOYER along with the bid. The EMPLOYER reserves the right the required spares during the tenure or on completion of annual maintenance contract at the quoted price which should be valid for the entire maintenance period i.e. five (5) years after DLP.

1.22 COMPENSATION FOR SHORTFALL IN CONTRACT RATINGS.

RATINGS / CAPACITIES OF THE PLANT

There shall be no credit to the CONTRACTOR if the output of the plant is higher than the rated capacity. There will be zero percent (0%) tolerance for the rated capacity on the negative sides.

During performance tests in case of any shortfall in the contracted system / equipment capacity, the Contractor will be given a chance to make adjustments after which the Performance test will be conducted again at the Contractors expense. In case the equipment does not meet the contract rating the equipment will have to be replaced at the cost of the Contractor within a reasonable period of time as will be indicated by the EMPLOYER and as per Performance as Guaranteed in the Tender.

1.23 **TAKING OVER CERTIFICATE**

As soon as the Works have been completed in accordance with the Contract and have passed the tests on completion, the Consulting ENGINEER will issue a provisional certificate (hereinafter called the provisional Taking over Certificate) in which he shall certify the date on which the Works have been successfully commissioned.

1.25 **BRAND NAME / MAKE OF EQUIPMENT**

For the main air-conditioning plant, Contractors are required to offer only the 'Brand' Make / as indicated elsewhere in the specification of to ensure fair evaluation of proposal. It is to be noted by the contractor that materials / equipment, for which brand / make has not been specified, the contractor shall use only reputed makes. The contractor shall submit a list of such brands / makes to the consulting engineer along with his offer for approval.

1.26 **SITE MANAGER & SITE ENGINEER**

The site engineer posted at site shall have adequate experience for handling a job of this magnitude. The resume of the site engineer shall be submitted to the Consulting engineer for approval along with the offer.

1.27 Consumable materials during construction, commissioning testing and subsequent warranty period

The Contractor shall supply at his own cost the following consumable materials as and when required.

(a) Complete water requirements including system requirements as well as water required for testing and commissioning.

(b) All oils and greases required for lubrication of compressors, fan bearings, motors bearings, pivots and other moving parts.

(c) All refrigerant required to replace refrigerant losses in the refrigerant systems.

(d) All consumable, filter elements / rolls.
(e) All Chemicals for the correct chemical treatment of the chilled water system.

(f) All carbon brushes required to replace worn brushers in electric motors.

(g) All electric contact points required to replace worn electric contact points in switchgears, motor starter gears, electronic control gears and electric relays.

(h) All electric fuses required to replace blown fuses.

(i) All cotton waste, soap detergent and other cleaning materials required for cleaning purpose.

The cost of these consumable materials shall be included in the contract Price.

After every inspection and service, the Contractor shall submit a written report to the EMPLOYER with a carbon copy extended to the Architect.

1.28 PAINTING & LABELLING

GENERAL

Unless otherwise specified, all exposed surfaces including trucking and cable tray, ductwork, equipment, etc., shall be thoroughly cleaned and painted.

All ferrous metal surfaces without protective finishes shall be painted, except surfaces of moving parts, which shall be thoroughly oiled and greased as required.

Non-ferrous surfaces may be left unpainted unless called for in this specification or required by the Architect for the purposes of colour coding and identification. Aluminium grilles and diffusers shall be powder coated with colour approved by the architects.

All bare surfaces requiring painting shall first be given a priming coat followed by an undercoat and two finishing coats.

SIGN WRITING

All major items of equipment shall be identified with approved names and / or numbers of suitable size in proportion to the size of the respective items.

Pipelines shall be painted in contrasting colour directional arrows adjacent connections, valves and branches and at intervals of not more than 2.5 mm. These arrows shall be 75 mm long on pipes up to 50 mm diameter and 150 mm long on pipes over 50 mm diameter.

All stop valves and control valves the function of which are not obvious shall be provided with a non-corroding metal or laminated plastic identification tag. The tag shall indicate the service, and the area or items, which the valve serves.

1.29 CONTROL OF NOISE & VIBRATION

This section of the specification covers the supply, delivery, installation and testing of Noise and Vibration Control equipment to be used in the isolation of the various Mechanical equipment as called for in this specification.

It is the intent of this specification that noise levels due to mechanical equipment and related services will be controlled to the design objectives stated herein, in all occupied areas. The requirements specified are considered to be the minimum precautions necessary to achieve these objectives. The entire installation shall operate without objectionable noise and vibration as determined by the Architect.

The contractor shall examine all drawings and specifications including architectural and structural sets of working documents, before commencing any work on the project and shall immediately bring to the Architect's attention any characteristics or properties of the building or any other factors which, in his opinion, would jeopardize or nullify the attainment of the design objectives.

The contractor shall guarantee that the complete plant and installation when operated within the design criteria shall acoustically perform to the noise criteria ratings specified.

MISCELLANEOUS EQUIPMENT

All equipment located above or under occupied areas and capable of producing noise or vibration shall be isolated from the structure.

SPECIAL CONDITIONS OF CONTRACT FOR PLUMBING WORKS

SECTION - I

1. **SCOPE OF WORK**

1.1 Work under this contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely furnish all the Plumbing and other specialized services as described hereinafter and as specified in the Schedule of Quantities and/or shown on the Plumbing Drawings.

This contract is an Item Rate Contract. All payments are made for the actual work executed. Any variation in the quantities will not have any extra cost implication on the quoted rates.

1.2 Without restricting to the generally of the foregoing the work shall include the following:-

a) Sanitary Fixtures.

b) Soil, Waste, Rain Water and Vent Pipes.

c) Water supply [Internal & External (Cold and Hot Water)].

d) External Sewerage/storm water drainage system

e) Water supply pumps and water treatment plants

f) Hot Water generation system

g) Solar System.

1.3 Services rendered under sub-section 1.4 shall be done without any extra charge.

1.4 The Contractor must get acquainted with the proposed site for the works and study Specifications and Conditions carefully before tendering. The work shall be executed as per

programme approved by the Engineer-In-Charge. If part of site is not available for any reason or there is some unavoidable delay in supply of materials stipulated by the Owner, the programme of construction shall be modified accordingly and the Contractor shall have no claim for any extras or compensation on this account.

1.5 Work area shall be the area shown in the plan attached.

2. SPECIFICATIONS

2.1 Work under this contract shall be carried out strictly in accordance with Specifications attached with the tender.

2.2 Items not covered under these Specifications due to any ambiguity or misprints, or additional works, the work shall be carried out as per Specifications of the latest Central Public Works Department with latest amendments as applicable in the contract.

2.3 Works not covered above para 2.1 and 2.2. shall be carried out as per relevant Indian Standards Specifications or Codes of Practice and, if not available, as per British Standards specifications or Codes of Practice or unified Plumbing Code of U.S.A.

2.4 The work shall be carried out strictly as specified in Schedule of Quantities and Technical Specifications. In case of any ambiguity, the details of particular item as given in Schedule of Quantities shall supersedes the details in Specifications.

3. EXECUTION OF WORK

3.1 The work shall be carried out in conformity with the Plumbing drawings and within the requirements of Architectural, HVAC, Electrical, Structural and Other specialized services drawings.

3.2 The Contractor shall cooperate with all trades and agencies working on the site. He shall make provision for hangers, sleeves, structural openings and other requirements well in advance to prevent hold up of progress of the construction programme.

3.3. On award of the work, Contractor shall submit a programme of construction in the form of a Pert Chart or Bar Chart for approval of the Engineer-In-Charge. All dates and time schedule agreed upon should be strictly adhered to, within the stipulated time of completion/commissioning along with the specified phasing, if any.

4. DRAWINGS

4.1 Plumbing drawings are diagrammatic but shall be followed as closely as actual construction permits. Any deviations made shall be in conformity with the Architectural and other services drawings.

4.2 Architectural drawings shall take precedence over Plumbing or other services drawings as to all dimensions.

4.3 Contractor shall verify all dimensions at site and bring to the notice of the Architects or Engineer-In-Charge all discrepancies or deviations noticed. Architects' decision shall be final.

4.4 Large size details and manufacturers dimensions for materials to be incorporated shall take precedence over small-scale drawings.

4.5 All drawings issued with the tender shall be returned in good conditions along with the tender.

4.6 All drawings/sketches issued by the Architects/Consultant for the works are the property of the Architects/Consultant and shall not be lent, reproduced or used on any works other than intended without the written permission of the Architects/Consultant.

5. INSPECTION AND TESTING OF MATERIALS

5.1 All materials before being allowed to be brought into the store will be preliminary / visually inspected at the entry gate of the project site before the security personnel. All materials shall be inspected by the Engineer-In-charge before receiving. This inspection will be conducted with the help of the quality approval format as prepared by the Clients.

5.2 Contractor shall be required, if requested, to produce manufacturers Test Certificate for the particular batch of materials supplied to him. The tests carried out shall be as per the relevant Indian Standards.

5.3 For examination and testing of materials and works at the site Contractor shall provide all Testing and Gauging Equipment necessary but not limited to the followings:-

a) Theodolite
b) Dumpy level
c) Steel tapes
d) Weighing machine
e) Plumb bobs, Spirit levels, Hammers
f) Micrometers
g) Thermometers, Stoves
h) Hydraulic test machine
i) Smoke test machine

5.4 All such equipment shall be tested for calibration and precision at an approved laboratory, if required by the Engineer-In-Charge.

5.5 All Testing Equipment shall be preferably located in special room meant for the purpose.

6. METRIC CONVERSION

6.1 All dimensions and sizes of materials and equipment given in the tender document are commercial metric sizes.

6.2 Any weights, or sizes given in the tender having changed due to metric conversion, the nearest equivalent sizes accepted by Indian Standards shall be acceptable without any additional cost.

7. REFERENCE POINTS

7.1 Contractor shall provide permanent Bench Marks, Flag Tops and other reference points for the proper execution of work and these shall be preserved till the end of the work.

7.2 All such reference points shall be in relation to the levels and locations given in the Architectural and Plumbing drawings.

8. REFERENCE DRAWINGS

The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on site.

All corrections, deviations and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings. All changes to be made shall be initialed by the Engineer-In-Charge.

9. SHOP DRAWINGS

9.1 Shop drawings shall be submitted under following conditions:-

(a) Typical details for Toilets & Fixtures required.

(b) Structural supports/hanging/laying and jointing details for all types of pipes as required.

(c) Plumbing layout plans as required and for any changes in the layout of Plumbing /Architectural Drawings.

(d) Equipment & piping layout for Mechanical and Electrical equipments as required, SLDs, mounting details of circuit breakers, location of panels, installation of terminals and faucets etc. w.r.t. finishes, surrounding levels & locations.

(e) Manufacturers and Contractor fabrication drawings

10. CONTRACTORS RATES

10.1 Rates quoted in this tender shall be inclusive of cost of materials, labour, supervision, erection, tools, plant, scaffolding, service connections, transport to site, taxes, breakage, wastage, if any, all such expenses as may be necessary and required to completely do all the items of work and put them in a working condition.

10.2 Rates quoted are for all heights and depths required for this work.

10.3 All rates quoted must be for complete items inclusive of all such accessories, Fixtures and fixing arrangements, nuts, bolts, hangers as are a standard part of the particular item except where specially mentioned otherwise.

10.4 All rates quoted are inclusive of cutting holes and chases in walls and floors and making good the same with cement mortar/concrete of appropriate mix and strength as directed by Engineer-In-Charge. Contractor shall provide holes, sleeves and recesses in the concrete and masonry work as the work proceeds.

10.5 Rates quoted shall be inclusive of cost incurred in testing, commissioning of works and materials including equipment etc.

10.6 The Contractor shall be responsible for any theft or breakage due to any reasons whatsoever till the time, the installations are handed over by the Contractor after their satisfactory Testing and Commissioning along with update amended drawings / detail of the work executed at site.

11. TESTING

11.1 Piping and drainage works shall be tested as specified under the relevant clauses of the specifications.

11.2 Tests shall be performed in the presence of the Engineer-In-Charge/ Consultant.

11.3 All materials and equipment found defective shall be replaced and whole work tested to meet the requirements of the specifications.

11.4 Contractor shall perform all such tests as may be necessary and required by the local authorities to meet Municipal or other bye-laws in force.

11.5 Contractor shall provide all labour, equipment and materials for the performance of the tests.

11.6 Contractor shall afford all the expenses for the offsite testing of material and equipments.

12 SITE CLEARANCE AND CLEANUP

12.1 The Contractor shall, from time to time clear away all debris and excess materials accumulated at the site during execution.

12.2 After the Fixtures, equipment and appliances have been installed and commissioned, Contractor shall clean-up the same and remove all plaster, paints stains, stickers and other foreign matter of discoloration leaving the same in a ready to use condition.

12.3 On completion of all works, Contractor shall demolish all temporary structure, stores, remove all surplus materials and leave the site in a broom clean condition, failing which the same shall be done at Contractors risk and cost.

12.4 All aforesaid expenditure involved in the site clearance and clean up shall be included in the Contract price.

13. LICENSE AND PERMITS

13.1 Contractor must hold a valid Plumbing license issued by the Municipal Authority or other competent authority under whose jurisdiction the work falls.

13.2 Contractor must keep constant liaison with all relevant authorities and shall be responsible for obtaining all approvals relating to water supply, sewerage, drainage system. He shall also be responsible for co-ordination for getting the approval , with other agencies working on the project relating to their scope of work.

13.3 Contractor shall obtain No Objection Certificate before commencement of work, from the local authorities all related to his work as required for the building.

13.4 Contractor shall obtain, from the local authorities all related completion certificates with respect to his work as required for occupation of the building.

13.5 All inspection fees or submission fees paid by the Contractor shall be reimbursed by the Owner on production of valid official receipts.

14. RECOVERY OF COST FOR MATERIALS ISSUED TO CONTRACTORS FREE OF COST

14.1 If any materials issued to the Contractor, free of cost, are damaged or pilfered, the cost of the same shall be recovered from the Contractor on the basis of actual cost to the Owner which shall include all freight and transportation, excise duty, sales tax, octroi, import duty etc. or the actual cost given by the Owner shall be final and binding on the Contractor.

15. CUTTING & MAKING GOOD

No structural member shall be chased or cut without the written permission of the Project Manager.

16. MATERIALS SUPPLIED BY THE OWNER

16.1 The Contractor shall verify that all materials supplied by the Owner conform to the specifications of the relevant item in the tender. Any discrepancy found shall be brought to the notice of the Engineer-In-Charge.

16.2 After receipt of materials, it shall be the responsibility of the Contractor for any damage found and he shall be liable to pay the actual cost of the material as per market rate at that time.

17. MATERIALS (SUPPLIED BY THE CONTRACTOR)

17.1 All materials used in the works shall conform to the tender specifications.

17.2 As far as possible all materials shall be bearing BSI/NBS certification marks as per approval of the Engineer-In-Charge.

17.3 All materials shall bear the necessary certification marks, conforming to the Tender Specifications / BOQ / Drawings requirements.

17.4 Unless otherwise specified and expressly approved in writing by the Engineer-In-Charge, materials of makes and specifications mentioned with tender shall be used.

18. MOCK UP AND TRIAL ASSEMBLY

The installation of Sanitary Fixtures and fittings shall be as per the shop drawings approved by Architect / Consultant.

The Contractor shall have to assemble at least one set of each type of Sanitary Fixtures and Fittings in order to determine precisely the required supply and disposal connections. Relevant instructions from manufacturers shall be followed as applicable. This trial assembly shall be developed to determine the location of puncture holes, holding devices etc, which will be required for final installation of all Sanitary fixtures and fittings. The above assembly shall be subject to final approval by the Architect / interior designers/Consultants/Engineer-in-charge .

The Fixtures in the trial assembly can be reused for final installation without any additional payments for fixing or dismantling of the fixtures.

19. **FINAL INSTALLATION**

The Contractor shall install all Sanitary fixtures and fittings in their final position in accordance with the approved trial assemblies and as shown on the Drawings. The installation shall be complete with all supply and waste connections. The connection between building and piping system and the sanitary fixtures shall be through proper unions and flanges to facilitate removal / replacement of Sanitary Fixtures without disturbing the built-in piping system. All unions and flanges shall match in appearance with other exposed fittings.

19.1 Fixtures shall be mounted rigid, plumb and true to alignment. The outlet of water closet pans and similar appliances shall be examined to ensure that outlet ends are butting and the receiving pipes before making the joint. It shall be ensured that the receiving pipes are clear of obstruction. When Fixtures are being mounted, attention shall be paid to the possibility of movement and settlement by other causes. Overflows shall be made to ensure that necessary anchoring devices have been provided foe supporting water closets, wash basins, sinks and other appliances.

20. **PROTECTION AGAINST DAMAGE**

The Contractor shall take every precaution to protect all Sanitary fixtures against damage, misuse, cracking, staining, breakage and pilferage by providing proper wrapping and locking arrangement till the completion of the installation and handling over. At the time of handling over, the Contractor shall clean, disinfect and polish all the fixtures and fittings. Any Fixtures found damped, cracked, chipped, strained or scratched shall be removed and new fixtures and fittings free from defects shall be installed at his own cost to complete the work.

21. **TESTING**

All appliances, fixtures and fittings shall be tested before and after installation. Water seals of all appliances shall be tested. The Contractor shall block the ends of waste and ventilation pipes and shall conduct air test.

22. **COMPLETION DRAWINGS**

22.1 On completion of work contractor shall submit one complete set of original tracings and two prints of “As Built” drawings for the Engineer-In-Charge. These drawings shall have the following information.

a) Run of all pipes with diameters and length on all floors and vertical stacks.
b) Ground and Invert levels of all Plumbing services pipes.
c) Location of all valves.
d) Location of all Mechanical equipment with layout and piping connection.

22.2 Contractor shall provide four sets of Test Certificate, Routine Type Test certificates for Motors, Dynamic balancing certificate for Impellers, Calibration certificate for instrument catalogues, Operation and Maintenance Manuals, performance data and list of spare parts supplied together with the name and address of the Manufacturers for all Mechanical and Electrical equipments provided by him in the form of a Book or Manual.

22.3 All "Warranty / Guarantee" cards / certificates in original issued by the manufacturers shall be handed over to the Engineer-In-charge also in the form of a comprehensive record book / documents.

SPECIAL CONDITIONS OF CONTRACT FOR FIRE FIGHTING WORKS

SECTION – I

1. GENERAL INSTRUCTIONS

1.1 Fire Fighting works specified in the tender have to be executed in accordance with:

1.1.1 The rules and regulations of Local Fire Authority as per the statutory regulations applicable for obtaining the occupation/No objection certificate from the Local Fire Authority.

1.1.2 The codes of the National Fire Protection Association of USA (N.F.P.A.) shall be used as a general guide for good engineering practice, design and workmanship norms. No certificate of compliance to NFPA codes will be required.

1.2 All materials used in the works shall have BSI/NBS valid certification stamped, marked or cast on the material in an acceptable and approved manner, as specified hereinafter.

1.3 It is the contractor's responsibility to ensure the compliance of design to meet the above requirements.

1.4 Drawings issued with the tenders are schematic and indicate the concept. Contractor shall make his shop drawings on the basis of Architectural and Interior design drawings issued by the Engineer-in-Charge. Work will be executed only as per approved shop drawings.

1.5 Quantities in the tender document are approximate worked out on the tender drawing.

1.6 Contractors are invited to highlight any aspects of the contract document that may need revision or reconsideration before the work is started. He must furnish details of any variations in the specifications or the quantities that may be necessary for him to comply with the Code and statutory requirements. These may be identified and approval of the Project managers taken before the start of the work.

1.7 Contractors shall furnish detailed Shop drawings, hydraulic and other design calculations for submission and approval of the Local Fire Authority and for Insurance Companies as may be required by the Client.

1.8 The Scope of work includes:

a) Internal wet riser system

b) External hydrant system

c) Sprinklers in floors

d) Portable Fire Extinguishers

e) Fire Fighting Pumps, pipe network and its accessories

1.9 SAFETY CODES AND LABOUR REGULATION

(i) In respect of all labour employed directly or indirectly on the work for the performance of the firefighting contractor's part of works, the contractor at his own expense, will arrange for the safety provision as per the statutory provisions, BSI/NBS recommendations, factory act, workman's compensations act, various code and instructions issued from time to time. Failure to provide such safety requirements would make the tenderer liable for penalty for each violation. In addition, the Engineer–in–charge shall be at liberty to make arrangements and provide facilities as afore said and recover the cost incurred thereon from the contractor.

(ii) The contractor shall provide necessary barriers, warning signals and other safety measures while laying pipelines, cables etc. or wherever necessary so as to avoid accidents. He shall also indemnify client against claims for compensation arising out of negligence in this respect. Contractor shall be liable, in accordance with the BSI/NBS for any accident occurring due to any cause. The Client shall not be responsible for any accident occurred or damage incurred or claims arising there from during the execution of work. The contractor shall also provide all insurance including third party insurance as may be necessary to cover the risk. No extra payment would be made to the contractor due to the above provisions thereof.

1.10 WORKS TO BE ARRANGED BY THE Client

Unless otherwise specified in the tender document, the following works shall be arranged by the Client.

(i) Space for accommodating all the equipment and components involved in the work,

(ii) Masonry ducts within and outside the building for carrying pipe lines and cables wherever specified.

1.11 MACHINERY FOR ERECTION

All tools and tackles required for unloading / handling of equipments and materials at site, their assembly, erection, testing and commissioning shall be the responsibility of the

contractor.

1.12 COMPLETENESS OF THE TENDER, SUBMISSION OF PROGRAM APPROVAL OF DRAWING AND COMMENCEMENT OF WORK

(i) Completeness of the tender:-
All sundry equipments, fittings, assemblies, accessories hardware items, foundation bolts, supports, termination lugs for electrical connection, cable glands, junction boxes and all other item which are useful and necessary for proper assembly and efficient working of the various equipments and components of the work shall be deemed to have been included in the tender, irrespective of the fact whether such items are specially mentioned in the tender or not.

(ii) Submission of the Program :-
Within fifteen days from the date of receipt the letter of award, the successful Tenderer shall submit his program for submission of drawings, supply of equipment, installation, testing, commissioning and handing over of the installation to the Engineer–in-charge. This program shall be framed keeping in view the building progress and the Milestones fixed in schedule 'F' clause-5 of General Conditions of contract. Item like piping etc. that directly affect the building progress shall be given priority. Hose pipes, branch pipes, first aid hose reel pipes shall be supplied just before commissioning the system.

1.13 DISPATCH OF MATERIALS TO SITE AND THEIR SAFE CUSTODY

The contractor shall dispatch materials to site in consultation with the Engineer–in–charge. Suitable lockable storage accommodation shall be made available free of charge temporarily, watch and ward however shall be the responsibility of contractor.

Program for dispatch of material shall be framed keeping in view the building progress. Safe custody of all machinery and equipment supplied by the contractor shall be the responsibility of the contractor till final taking over by the department.

1.14 CO-ORDINATION WITH OTHER AGENCIES

The contactor shall co-ordinate with all other agencies involved at the site of the work, so that the work of other agencies is not hampered due to delay in his work. Piping, Cabling or any other work, which directly will affect the progress of work of other agencies, shall be given priority.

1.15 QUALITY OF MATERIALS AND WORKMANSHIP

(i) The components of the installation shall be of such design so as to satisfactorily function under all conditions of operation.
(ii) The entire work of manufacture / fabrication, assembly and installation shall confirm to sound engineering practice.
(iii) All equipments and materials to be used in work shall be manufactured in factories of good repute having excellent track record of quality manufacturing, performance and proper after-sales service.

1.16 CARE OF THE BUILDING

Care shall be taken by the contractor during execution of the work to avoid damage to the building. He shall be responsible for repairing all such damages and resting the same to the original finish at his cost. He shall also remove all unwanted and wasted materials arising out of the installation from the site of work from time to time.

1.17 INSPECTION AND TESTING

1.17.1 Initial inspection and testing

(i) Initial inspection of materials and equipments and manufacturer's works may be done by the Engineer–in-Charge or his representative. For item /equipment requiring initial inspection at manufacturer's work, the contractor will intimate the date of testing of equipments at the manufacturer's works before dispatch. The contractor shall give sufficient advance notice regarding the dates proposed for such tests to the department's representative(s) to facilitate his presence during testing. The Engineer–in-charge at his discretion may witness such testing. Equipments will be inspected at the manufacturer/authorized dealer's premises, before dispatch to the site by the contractor.

(ii) The Client also reserves the right to inspect the fabrication job at factory and the successful tenderer has to make arrangement for the same.

(iii) The material duly inspected by Engineer-in-Change or his authorized representative shall be dispatched to site by the contractor.

(iv) No additional payment shall be made to the contractor for initial inspection/testing at the manufacturer's works by the representative of the Engineer–in-charge. However, the client will bear the expenses of its representative deputed for carrying out initial inspection/testing.

1.18 Final inspection and testing

Final inspection and testing will be done by the Engineer–in-Charge or his representative. The installation will be offered for inspection by local bodies. The contractor or his representative shall attend such inspection of the chief fire officer, extend all test facilities as are considered necessary, rectify and comply with all observations of the chief fire officer which are part of the agreement. In case the contractor fails to attend the inspection and make desired facilities available during inspection, the client reserves the right to provide the same at the risk and cost of the contractor and impose penalty for the same. The installation will be accepted by the department only after receiving clearance from Chief Fire Officer for the work executed by the contractor under the agreement.

1.19 Safety Measures

All equipment shall incorporate suitable safety provision to ensure safety of the operating personal at all the times. The initial and final inspection reports shall bring out explicitly the safety provisions incorporated in each equipment.

1.20 GUARANTEE

(i) The contractor shall guarantee the complete system to provide the specified flow and pressure under all conditions and outlets.

(ii) All equipments shall be guaranteed for a period of 60 month from the date of acceptance and taking over of the installation by the client against unsatisfactory performance and/or breakdown due to defective design, material, manufacture, workmanship or installation. The equipment or component or any part thereof so found defective during the guarantee period shall be repaired or replaced free of cost to the satisfaction of the Engineer–in-Charge. In case it is felt by the client that undue delay is being caused by the contractor in doing this, the same will be got done by the department at the risk and cost of the contractor. The decision of Engineer –in-Charge in this regard shall be final.

1.21 TENDER DRAWINGS

The drawing appended with the tender document is intended to show the areas
Allotted for various equipments, tentative pipe routes .The equipment offered shall be suitable for installation in the spaces shown in these drawing .The details of the drawing are given as under.

(a) Lay out drawing of the equipments to be installed in pump room and terrace.

(b) Drawing showing the details of erection of entire equipment including their foundations.

(c) Firefighting drawing showing the layout of entire piping, dia and length of pipes hydrant, air vessel, valves and isometric drawing showing connection to various equipment.

(d) Sprinkler drawing indicating layout and size of pipe, Location of valves, sprinklers etc.

(e) Electrical wiring diagrams for all electrical equipment and controls including the sizes and capacities of the various cables and equipments.

(f) Dimensioned drawings of all electrical and control panels.

(g) Drawing showing details of supports for pipes, cable treys etc. .

(h) Any other drawing relevant to the work.

1.22 Water Storage & Pump House

1.22.1 A static underground RCC water storage tank in two compartments or as shown in the drawing having gross water storage of required capacity will be provided. The tank will be provided with manholes, inserts, puddle flanges, ladders inside and outside the tanks by the civil contractor.

1.22.2 Overhead water storage tank of required capacity on each Block as a secondary water source

for the sprinkler system will be provided on the terrace.

1.22.3 Configuration and operating conditions of pumps are given in the Specifications.

1.23 Wet Riser Hydrant System

- The building will be provided with a wet riser system. Hydrants are fed from a 150/100 mm dia M.S. pipe endless ring main. The ring main will be provided with three isolation valves to enable at least a part of the main to provide water in case a section is under repairs.

- External fire hydrants will be provided on the ring main. Hydrants shall be located at least 2 m away from the building. Internal wet risers for the building shall be connected to the ring main with a non return valve and a fire brigade inlet connection with isolation butterfly valve for each wet riser connection.

- Hydrant stations and cabinets shall be provided at all designated locations inside and along with the external hydrants. The hydrant stations shall be located in fire cabinets as per drawings and will contain all items described in the Schedule of work and specifications.

1.24. Sprinkler System

- The building is also protected with automatic sprinkler system as per requirement with permitted exceptions e.g., electrical switch rooms, power transformers and D.G. rooms, Panel rooms, Electrical rooms as identified.

- Types of sprinklers to be used shall be as given in specifications, Schedule of work to be got approved by the Engineer -in -charge.

1.25. Pumping System

- The pumping system shall provide the water supply and pressure to the wet riser fire and sprinkler mains. Diesel Engine will be a common stand by.

- Provide a full-bore test valve on the bypass line with rate of flow meter on the common pump header to discharge in the water tank. Also provide an isolation valve on headers outlet to each circuit to enable pressure setting and testing of pumps.

1.26 INSPECTION AND TESTING OF MATERIALS

- All material before allowing to bring at the store, will be preliminary / visually inspected at the entry gate of the project site.

  This inspection will be conducted with the help of the quality approval format as prepared by the clients.

- For examination and testing of materials at the working site, the Contractor shall provide all Testing and Gauging Equipment as necessary.

- All such equipment shall be tested for calibration at any approved laboratory, if required by the Engineer-in-Charge.

- All Testing Equipment shall be preferably installed in special room meant for the purpose.

1.27 METRIC CONVERSION

- All dimensions and sizes of materials and equipment given in the tender document are commercial metric sizes.

- Any weights, or sizes given in the tender having changed due to metric conversion, the nearest equivalent sizes accepted shall be acceptable without any additional cost.

1.28 REFERENCE POINTS

- Contractor shall provide permanent Bench Marks, Flag Tops and other reference points for the proper execution of work and these shall be preserved till the end of the work.

- All such reference points shall be in relation to the levels and locations given in the Architectural and Firefighting drawings.

1.29 REFERENCE DRAWINGS

The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on site.

All corrections, deviations and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings. All changes to be made shall be initialed by the Engineer-in-Charge.

1.30. SHOP DRAWINGS

- The Contractor shall submit two copies of Shop Drawings as an advance copy to the Engineer-in-Charge for approval before start of work. Subsequent to the approval of the shop drawings, the Contractor shall submit six copies of shop drawings for execution to the Engineer-in-Charge.

- The Contractor shall submit four copies catalogues, manufacturers drawings, equipment characteristic data or performance charts as required by the Engineer-in-Charge.

1.31. COMPLETION DRAWINGS

- On completion of work, Contractor shall submit one complete set of original tracings and two prints of “as built” drawings to the Engineer-in-Charge. These drawings shall have the following information:

(a) Run of all piping with diameters on all floors and vertical stacks.

(b) Ground and invert levels of all firefighting pipes.

(c) Location of Control Valves.

(d) Location of all Mechanical equipment with layout and piping connections.

- Contractor shall provide four sets of catalogues, manuals, performance data and list of spare parts together with the name and address of the manufacturer for all Electrical and Mechanical equipment provided by him in the form of a book of manuals.

- All "Warranty cards" given by the manufacturers shall be handed over to the Project Manager also in the form of a comprehensive record book / documents.

1.32 CONTRACTORS RATES

- Rates quoted in this tender shall be inclusive of cost, unless specified of materials, labor, supervision, erection, tools, plant, scaffolding, service connections, transport to site, taxes, octroi and levies, breakage, wastage, sales tax on works contract and all such expenses as may be necessary and required to completely to do all the items of work and put them in a working condition.

- Rates quoted are for all heights lift and depths required for this work.

- Unless specified, all rates quoted are inclusive of cutting holes and chases in walls and floors and making good the same with cement mortar/concrete of appropriate mix and strength as directed by Engineer-in-Charge. Contractor shall provide holes, sleeves and recesses in the concrete and masonry work as the work proceeds.

- Rates quoted shall be inclusive of cost incurred in testing, commissioning of works and materials.

1.33 TESTING

- Piping and drainage works shall be tested as specified under the relevant clauses of the specifications.

- Tests shall be performed in the presence of the Engineer-in-Charge/ Consultant.

- All materials and equipment found defective shall be replaced and whole work tested to meet the requirements of the specifications.

- Contractor shall perform all such tests as may be necessary and required by the local authorities to meet Municipal or other bye-laws in force.

- Contractor shall provide all labor, equipment and materials for the performance of the tests.

1.34 SITE CLEARANCE AND CLEANUP

- The Contractor shall, from time to time clear away all debris and excess materials accumulated at the site.

- After the Fixtures, equipment and appliances have been installed and commissioned, Contractor shall clean-up the same and remove all plaster, paints stains, stickers and other foreign matter of discoloration leaving the same in a ready to use condition.

- On completion of all works, Contractor shall demolish all stores, remove all surplus materials and leave the site in a broom clean condition, failing which the same shall be done at Contractors risk and cost.

1.35 All aforesaid expenditure involved in the site clearance and cleanup are included in the contract price.

1.36 LICENSE AND PERMITS

- Contractor must keep constant liaison with all relevant authorities and shall be responsible for obtaining all approvals relating to firefighting system. He shall also be responsible for co-ordination for getting the approval, with other agencies working on the project relating to their scope of work.

- Contractor shall obtain, from the local authorities all related completion certificates with respect to his work as required for occupation of the building.

- All inspection fees or submission fees paid by the Contractor shall be reimbursed by the Employer on production of valid official receipts.

1.37. RECOVERY OF COST FOR MATERIALS ISSUED TO CONTRACTORS FREE OF COST

If any materials issued to the Contractor, free of cost, are damaged or pilfered, the cost of the same shall be recovered from the Contractor on the basis of actual cost to Owner which shall include all freight and transportation, excise duty, sales tax, octroi, import duty etc. or the actual cost given by the Employer shall be final and binding on the Contractor.

1.38. CUTTING & MAKING GOOD

No structural member shall be chased or cut without the written permission of the Engineer-in-Charge.

1.39. MATERIALS

- All materials used in the works shall conform to the tender specifications.

- As far as possible materials bearing I.S. certification marks shall be used with the approval of the Engineer-in-Charge.

- Unless otherwise specified and expressly approved in writing by the Engineer-in-Charge, materials of makes and specifications mentioned with tender shall be used.

1.40 MOCK UP

The Contractor shall install all pipes, clamps and accessories and fixing devices in mock-up shaft and room so constructed as directed by Engineer-in-Charge without any extra cost. The materials used in the mock-up may be reused in the works if found undamaged.

Any tiles or finished surfaces or floors damaged by the Contractor while doing his work shall be made good with new tiles or other finishing material. No payment shall be admissible for such repairs. The Engineer-in-Charge may, at his discretion get the damaged work repaired by other agencies and debit the cost of such repairs to the Contractor.

TECHNICAL SPECIFICATIONS

SUB-HEAD: A. CONDUIT, ACCESSORIES & FIXING ARRANGEMENT

1. RIGID PVC CONDUIT & ACCESSORIES

PVC conduits shall be high impact, rigid, FRLS PVC, heavy-duty type and shall comply with relevant Standards.

Conduits unto 32mm dia shall be 2mm thick and above that shall be 2.5mm thick.

Plain conduits shall be joined by slip type of couplers with approved sealing cement. All conduit entries to outlet boxes are to be made with adaptors female thread and screwed male bushes. Conduit fittings and accessories such as inspection boxes, draw boxes and junction boxes shall be of heavy-duty rigid PVC installed in such a manner that they can remain accessible for existing wires or for the installation of the additional wires. Fan hook box shall be of M.S. Inspection boxes shall be covered with suitable covers.

Conduit runs shall be so arranged that the cables connected to separate main circuits shall be enclosed in separate conduits and that all lead and return wires of each circuit shall be run with the same circuit.

PVC 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 glued properly. All joints shall be fully water tight. All jointing of PVC conduits shall be by means of adhesive jointing.

2. RIGID MS CONDUIT/GI CONDUIT & ACCESSORIES

Rigid MS conduits shall conform to relevant International Standards. MS ERW conduits protected inside & outside by black stove enamel shall be used as called for in the schedule of quantities.

Conduit up to 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. Fan hook box shall be of M.S. Inspection boxes shall be covered with 16 G GI covers. All conduit accessories shall be threaded type only.

Conduit runs shall be so arranged that the cables connected to separate main circuits shall be enclosed in separate conduits and that all lead and return wires of each circuit shall be run with the same circuit.

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 International Standards. These conduits shall be protected by hot dip galvanized coating both inside and outside.

3. FLEXIBLE CONDUITS

Flexible conduits shall be made of heavy gauge MS strip galvanized after making the spiral. Both edges of the strip to have interlocking to avoid opening up.

4. 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.

Separate conduits shall be laid for the following systems:

a) Normal light, Fan and 6 A socket outlets.
b) Power points.
c) TV outlets.
d) PA/ Paging system.

e) Telephone points and Data Points
f) Fire alarm system.
g) UPS points.
h) CCTV System
i) Access Control System
j) Emergency Lighting

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.

SUB-HEAD: B. **WIRING AND WIRING ACCESSORIES**

1. GENERAL

All the internal wiring shall be with 1100 V grade, single or multi core HR FRLS, PVC insulated,

2. COLOUR CODING

Colour coding of wiring shall be done as per BSI/NBS specifications, for identification of different circuits and phases. All wiring shall be in concealed or surface conduits as called for.

In three phase feeder circuit, three phase wire, with or without neutral wire, shall be taken through any single conduit. In lighting and power socket outlets wiring, in no case two lives wires of different phases shall be drawn through the same conduit.

3. SWITCH

All switches shall be connected to live wire and neutral of each circuit shall be continuous everywhere having no fuse or switch installed in the line except at the main switch board.

4. INSTALLATION

The conduits and wiring installation are to be installed such that modifications or repairs can be carried out in future without disturbing the building fabric in any way.

For wiring accessories partly recessed in wall, special care must be taken to ensure that the final position of all switch\ socket plates is set symmetrical with the pattern of the wall finish as required by the architect. All switch socket-mounting plates shall be set square to the vertical and horizontal axis.

5. FISH WIRE

GI Fish wire / Pull wire of 14G shall be provided in the recessed conduiting to facilitate pulling of wires through conduits.

6. INSPECTION BOXES

Inspection boxes / Pull boxes shall be provided as required and approved by the Architect / Consultant for pulling of wires through conduiting network. Rigid PVC boxes shall be used for the PVC conduiting and C.I. boxes of suitable size and depth shall be used for MS / GI conduiting.

7. JOINTS

Only looping system of wiring shall be used. Wires shall not be jointed/ taped. All joints shall be made at switches, sockets outlets, distribution boards and lighting points. No joints shall be made inside conduits and in junction boxes. Suitable sizes connectors to be used at light fixtures. No reduction of strands is permitted at terminations. Before connections, copper conductor wire ends shall be properly soldered (at least 20-mm length). Terminals shall have adequate cross-sectional area to take all strands. No wire smaller than 1.5 sq.mm shall be used.

8. IDENTIFICATION

Identification ferrules indicating the circuit and D.B. number shall be use for sub mains and sub-circuit wiring. The Ferrules shall be provided at both ends of each sub-main and sub-circuit.

9. CIRCUITS OF DIFFERENT PHASES & DIFFERENT DB's

Where single-phase circuits are supplied from a three phase and neutral distribution board, no conduit shall contain the wiring of different phases. Circuits fed from distinct sources of supply \ from different distribution boards or MCB's shall not be bunched in one conduit.

10. LOAD BALANCING, CONTROL & EARTH WIRE

Load Balancing of circuits in three-phase installation shall be arranged before installation is taken up. The earth continuity green FRLS PVC insulated copper wire for individual circuits of light / power / UPS should be laid. From D.B. each circuit will have separate earth wire. Earth wire shall be run inside the conduit to earth the third pin of socket outlets, earth terminal of light fixtures & fans etc. & earth terminals of outlet box as required. Light points shall be either of single control, twin control & multiple points controlled by a single switch / MCB as per schedule of works. Insulated copper wire for earthing as specified in the item of work shall be provided with each circuit and terminated in the earth bar of DB's / Switch boxes with proper lugs, as required.

11. CONDUIT FILL

Number of wires in each conduit shall be drawn as per chart given below:

MAXIMUM PERMISSIBLE NUMBER OF 1100 V GRADE FRLS PVC INSULATED COPPER CONDUCTOR WIRES THAT CAN BE DRAWN INTO METALLIC AND NON-METALLIC CONDUITS:

Maximum number of PVC insulated 650/1100V grade aluminum /copper Conductor cable.

Nominal cross-sectional area of conductor in sq.mm	20mm		25mm		32mm		38mm		51mm		64mm	
	S	B	S	B	S	B	S	B	S	B	S	B
1	2	3	4	5	6	7	8	9	10	11	12	13
1.50	5	4	10	8	18	12	-	-	-	-	-	-
2.50	5	3	8	6	12	10	-	-	-	-	-	-
4	3	2	6	5	10	8	-	-	-	-	-	-
6	2	-	5	4	8	7	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-
16	-	-	2	2	3	3	6	5	10	7	12	8
25	-	-	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	-	-	3	2	6	5	8	6

Notes:

1. The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.
2. The columns headed 'S' apply to runs of conduits which have distance not exceeding 4.25m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns headed 'B' apply to runs of conduit, which deflect from the straight by an angle of more than 15 degrees.

3. Conduit fill shall not exceed 40%.

12. WIRING AND EARTHING NORMS

Light Points, 6 A sockets and fans points may be wired on a common circuit. Not more than 10 light points, 6 A sockets and fan points and a load not exceeding 800 W be connected on a lighting circuit unless it is specified otherwise on the drawings/ in the schedule of quantities. It will however, be preferred to have separate circuits of 6A sockets as may be required by the consultant. Size of the earth wire shall be of the same size as that of the live / phase conductor unless specified otherwise. It shall however, be ensured that in one switchboard, only one circuit is terminated. For different circuits, separate switch boards shall be used. Each power circuit shall be wired as specified in drawings/schedule of quantities. Not more than two power points 6A/16A sockets shall be connected on one power circuits unless specified differently in the drawings/schedule of quantities.

UPS circuits shall start from the UPS DB's. UPS points will have two insulated green earth wires, one for the earthing of the 3rd pin of the socket and other for the earthing of the outlet box/furniture.

The smallest copper conductor to be used for lighting circuits shall be of 1.5/2.5 sq. mm (as specified in the schedule of quantities) and for power circuit 4 sq. mm respectively. Wiring shall be done in the looping system. Phase or live conductor shall be looped at the switch box and neutral conductor can be looped from the light, fan or socket outlet. Neutral conductor and earth continuity wire shall be brought to each switchboard situated in rooms/ halls. These shall be terminated inside the switchboards with suitable connectors.

SUB-HEAD: C. **SWITCHES, SOCKETS & ACCESSORIES**

1. MODULAR SWITCHES

All 6- and 16-amps switches shall be clip in switch modules. Switches shall be with positive action rockers clipped on to modular front plates and shall be suitable for 230 volts AC. Switches & plates shall be made out of Fire-retardant UV stabilized Engineering thermo plastic (grade poly carbonate). All modular plates shall be fixed to the switch boxes with brass screws, leaving ample space at the back and sides for accommodating wires. All switches shall conform to BSI/NBS amended and revised to date. Switches controlling the lights shall be connected to the phase wire of the circuit.

2. MODULAR SOCKET OUTLET

Socket outlets shall be clip in modules, clipped on to modular front plates and shall be 3/5/6 pin round or flat pin or universal or international type as called for in the Schedule of Quantities. Socket outlets and plates shall be made out of Fire-retardant UV stabilized Engineering thermo plastic (grade poly carbonate). GI outlet box shall have an earth terminal. The earth terminal of the socket shall be connected to the earth terminal provided inside the box.
Each socket outlet shall be controlled by a switch. The switch controlling socket outlet shall be on live side/phase wire of the circuit.

3. POWER OUT-LETS

Each socket outlet shall be controlled by a switch. The switch controlling socket outlet shall be on live side of the circuit.

Switches and Sockets shall have Silver Cadmium contacts for long life. Live terminals should be shrouded for finger protection.

All 3 pin / 6 pin socket outlets shall be child resistant shuttered system.

4. MODULAR FAN REGULATORS & DIMMERS

Fan regulator shall be clip in modular type suitable for 230V AC. The minimum rated power shall be 120W. The regulator shall be totally hum free. The fan regulator shall have “Off” position. The fan regulator shall be clipped on to modular front face plate.

The dimmer shall be clip in modular type suitable for 230V AC. The minimum rated power shall be 400W. The dimmer shall have “Off” position. The dimmer shall be clipped on to modular front face plates.

These shall be made of Fire retardant, UV Stabilized, and engineering thermo plastic. Dimmers and fan regulators operation should not interfere with radio & TV signal.

5. METAL OUTLET BOXES

16 G GI outlet boxes of suitable size as per the requirement of modular front plate shall be used. The outlet box shall be of minimum depth of 50mm unless otherwise specified differently. GI outlet box shall have a brass earth terminal.

6. PLASTIC OUTLET BOXES

Plastic enclosures / outlet boxes where ever required shall be of suitable size as required for the switch / socket front face plates and shall be made of UV stabilized engineering plastics.

7. MODULAR COMMUNICATION OUTLETS

TV, Tele & Data outlets shall be modular type clipped on to suitable modular front plates on suitable outlet boxes. These are made of engineering thermo plastics. TV outlet shall be Co-axial, Sliver plated for minimal signal loss.

Tele Jack, (RJ-11) shall accept minimum 2 lines, gold plated contacts for better voice clarity and with spring loaded shutter for dust protection. Data outlet (RJ 45) shall be able to accept Cat 6 cable, gold plated contacts for better data transfer efficiency and spring-loaded shutter for dust protection.

8. PLATE SWITCHES AND SOCKETS

Plate switches and sockets shall be suitable for 230V AC supply and made out of Urea formaldehyde thermo setting resin. Switches shall be rocker operated. Socket shall be shuttered. All current supply contacts shall be with Silver Cadmium Oxide contact tips. All sockets shall in corporate phosphorus bronze contacts. Suitable sized 16G GI outlet boxes with earth studs to be used.

9. TYPE OF SOCKET OUTLETS (to be used as specified in the B.O.Q.)

a. 6 Amps. 3 Pin Round

b. 6 Amps. 5 Pin Round

c. 16 Amps. 3 Pin Round

d. 6A/16 Amp. 6 Pin Round

e. 6 Amps. 3 Pin Universal

f. 13 Amps. 3 Pin Flat

g. 6 Amps. 3 Pin International (Intel Socket)

SUB-HEAD: D. **LT CABLES - 1.1 KV GRADE**

1. GENERAL

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

2. MATERIAL

2A. Specification of 1.1KV grade Single / Multicore PVC insulated, PVC sheathed Aluminium / Copper conductor Armoured / Unarmoured cables shall be as BSI/NBS:

i. Conductor:

- Material : Aluminium / Copper
- 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 : PVC Type-A (Red, Yellow, Blue & Black)
iii. Inner Sheath : PVC
iv. Armouring : Single layer of galvanized steel round wires / flat strips
v. Outer sheath : PVC Type
vi. Colour of sheath : Black

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

2B. Specification of 1.1KV grade Single / Multicore XLPE insulated, PVC sheathed Aluminium / Copper conductor Armoured / Unarmoured cables shall be as per BSI/NBS:

i. Conductor:

- Material : Aluminium / Copper
- 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 : PVC Type ST-2
iv. Armouring : Single layer of galvanized steel round wires / flat strips
v. Outer sheath : PVC Type
vi. Colour of sheath : Black

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

2C. Specification of 1.1KV grade Single / Multicore XLPE insulated, FRLS Type Aluminium / Copper conductor Armoured / Unarmoured cables shall be as per BSI/NBS:

i. Conductor:

- Material : Aluminium / Copper
- 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 : PVC Type ST-2
iv. Armouring : Single layer of galvanized steel round wires / flat strips
v. Outer sheath : PVC Type FRLS
vi. Colour of sheath : Black

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

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 wheel 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 BSI/NBS 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 sulphuric 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 & 40mm 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 BSI/NBS.

a. Quality of Zinc

Zinc to be used shall conform to minimum Zn 98 grade .

b. Coating Requirement

Minimum weight of zinc coating for mild steel flats with thickness upto 6 mm.

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 Laboure 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: E. **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. 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.

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 BSI/NBS.

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 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	Galvanized 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 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.

b. Coating Requirement

Minimum weight of zinc coating for mild steel flats with thickness upto 6 mm 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.

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 be manufactured by a manufacturer listed in approved makes of material changes in make can only done after prior written permission of Architect/Consultant/Owner.

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 BSI/NBS 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 BSI/NBS.

4 PAINTING

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivating (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of Colour of FDB inside/outside shall be of Siemens gray paint shade no. RAL-7032 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:
a. Factory-built assemblies of switch gear for voltages upto and including 1000 VAC.
b. For Degree of protection

7 WIRING

In wiring an 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 <u>Pre-commissioning Test for Final Distribution Boards</u>

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: G. LT SWITCH GEAR

1. AIR CIRCUIT BREAKERS (ACB)

1.1 The ACB shall confirm to the requirements of IEC 60947-2 and shall be type tested & certified for compliance. The circuit breaker shall be suitable for 415 V + 10%, 50 Hz supply system. Air Circuit Breakers shall be with moulded housing flush front, draw out type and shall be provided with a trip free manual operating mechanism or as indicated in drawings and bill of quantities with mechanical "ON" "OFF" "TRIP" indications.

The ACB shall be 3/ 4 pole with modular construction, draw out, manually or electrically operated version as specified. The circuit breakers shall be for continuous rating and service short Circuit Breaking capacity (Ics) shall be as specified on the single line diagram / in the B.O.Q/ as required for the application and should be equal to the Ultimate breaking capacity(Icu) and short circuit withstand values(Icw) for 1 sec.

Circuit breakers shall be designed to 'close' and `trip' without opening the circuit breaker compartment door. The operating handle and the mechanical trip push button shall be at the front of the breakers panel. Inspection of main contacts should be possible without using any tools. The ACB shall be provided with a door interlock. i.e., door should not be open when circuit breaker is closed and breaker should not be closed when door is open.

All current carrying parts shall be silver plated and suitable arcing contacts with proper arc chutes shall be provided to protect the main contacts. The ACB shall have double insulation (Class-II) with moving and fixed contacts totally enclosed for enhanced safety and in accessibility to live parts. All electrical closing breakers shall be with electrical motor wound stored energy spring closing mechanism with mechanical indicator to provide ON/OFF status of the ACB.

The auxiliary contacts blocks shall be so located as to be accessible from the front. The auxiliary contacts in the trip circuits shall close before the main contacts have closed. All other contacts shall close simultaneously with the main contacts. The auxiliary contacts in the trip circuits shall open after the main contacts open.

Minimum 4 NO and 4 NC auxiliary contacts shall be provided on each breaker.

Rated insulation voltage shall be 1000 volts AC.

1.2 CRADLE

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

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

Racking Interlock in Connected/Test/Disconnected Position.

Service Position: Main Isolating contacts and control contacts of the breaker are engaged.
Test Position: Main Isolating contacts are isolated but control contacts are still engaged.
Isolated Position: Both main isolating and control contacts are isolated.

There shall be provision for locking the breaker in any or all of the first three positions.
The following safety features shall be incorporated:

a. Withdrawal or engagement of Circuit breaker shall not be possible unless it is in open condition.
b. Operation of Circuit breaker shall not be possible unless it is fully in service, test or drawn-out position.
c. All modules shall be provided with safety shutters operated automatically by movement of the carriage to cover exposed live parts when the module is withdrawn.

d. All Switchgear module front covers shall have provision for locking.
e. Switchgear operating handles shall be provided with arrangement for locking in 'OFF' position.

1.3 PROTECTIONS

The breaker should be equipped with micro-controller-based release to offer accurate and versatile protection with complete flexibility and shall offer complete over current protection to the electrical system in the following four zones:

- Long time protection.
- Short time protection with intentional delay.
- Instantaneous protection.
- Ground fault protection.

The protection release shall have following features and settings:

a. **True RMS Sensing**

The release shall sample the current at the rate of 16 times per cycle to monitor the actual load current waveform flowing in the system and shall monitor the true RMS value of the load current. It shall take into account the effect of harmonics also.

b. **Thermal Memory**

When the breaker shall reclose after tripping on overload, then the thermal stresses caused by the overload if not dissipated completely, shall get stored in the memory of the release and this thermal memory shall ensure reduced tripping time in case of subsequent overloads. Realistic Hot/Cold curves shall take into account the integrated heating effects to offer closer protection to the system.

c. **Defined time-current characteristics :**

A variety of pick-up and time delay settings shall be available to define the current thresholds and the delays to be set independently for different protection zones thereby achieving a close-to-ideal protection curve.

d. **Trip Indication**

Individual fault indication for each type of fault should be provided by LEDs for faster fault diagnosis.

e. **Self-powered**

The release shall draw its power from the main breaker CT's and shall require no external power supply for its operation.

f. **Zone Selective Interlocking**

The release shall be suitable for communication between breakers to enable zone selective interlocking. This feature shall be provided for both short circuit and ground fault protection zones to offer intelligent discrimination between breakers. This feature enables faster clearance of fault conditions, thereby reducing the thermal and dynamic stresses produced during fault conditions and thus minimizes the damage to the system. To implement ZSI manufacturer should supply all related equipment like power supply, wiring etc.

On-Line change of settings should be possible. It should be possible to carry out testing of release without tripping the breaker.

g. The release shall meet the EMI / EMC requirements.

h. The setting range of release shall be as follows:

	SETTING RANGE OF RELEASE	
TYPE OF PROTECTION	**PICK-UP CURRENT**	**TIME DELAY**
Long Time	0.4 to 1.0 times In (Ir) Steps : 0.04, 0.05, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.00. Operating Limit : 1.05 to 1.2 times Ir	0.5 to 30 sec at 6 Ir Steps 0.5,1, 2,4, 6, 8,12,18,24 and 30 secs Tolerance : Corresponding to ±10% of current.
Short Time	2 to 10 times Ir Steps : 2,3,4,5,6,7,8,9 & 10 Tolerance : ±10%	20 ms to 600 ms Steps 20,60,100,160,200,260,300 400,500 and 600 ms Tolerance : ±10% or 20ms whichever is higher
Instantaneous	2 to 12 times In Steps : 2,3,4,6,8,10,12	

	Tolerance : ±10%	
Ground Fault	0.2 to 0.6 time In Steps : 0.2,0.3,0.4,0.5,0.6 Tolerance : ±10%	100 ms to 400 ms Steps : 100,200,300,400ms Tolerance : +10% or 20 ms Whichever is higher.

All **incomer** ACB's shall have following additional protections other than mentioned above:

- Under and over voltage
- Under and over frequency
- Restricted Earth Fault protection
- Trip Circuit supervision with PS class CT's.
- Undercurrent
- Reverse power
- Phase sequence reversal (for DG set only)
- Load shedding and reconnection thru programmable contacts.
- Release should display the Contact wear indication.

The release should provide local indication of actual %age loading at any instant. The release should be able to communicate on MODBUS RTU protocol using inbuilt RS485 port and shall be integral part of supply with trip unit. Parameters of the Protection Release should be changeable from Release as well as thru communication network. Release should have graphical LCD for display of power parameters. The release should provide comprehensive metering with the following parameters.

- Phase currents (running, avg & max) – All parameters in single window.
- Release should be able to capture short circuit current on which ACB has tripped. The last ten trips and alarms shall be stored in memory with the date & time stamping along with type of fault and alarm. The sensing CT should be Rogowsky type with measurement precision of 1%.
- Release should be self-powered.
- Release should have facility to select different type of IDMTL protection (DT, SIT, VIT, EIT, HVF) for better co-ordination with HT Breaker/Fuse.
- Phase voltages (running, avg & max)
- Energy & power parameters (active, reactive and apparent)
- PF
- Frequency
- Maximum Demand (KVA & KW)
- Total Harmonics distortion

All **O/G** ACBs shall have following functions:

Protection

- The ACB control unit shall offer the following protection functions as standard: Long-time (LT) protection with an adjustable current setting and time delay;
- Short-time (ST) protection with an adjustable pick-up and time delay;
- Instantaneous (INST) protection with an adjustable pick-up and an OFF Position.
- Current and time delay setting shall be indicated in amperes and seconds respectively on a digital display.
- Earth-fault protection with an adjustable pick-up and time delay shall be provided if indicated on the appended single-line diagram.

Measurements

- An ammeter with a digital display shall indicate the true rms values of the currents for each phase. Release shall acknowledge the current & time delay settings done by user on the LCD display.
- A LED bar graph shall simultaneously display the load level on the three phases.
- A maxi meter shall store in memory and display the maximum current value observed since the last reset. The data shall continue to be stored and displayed even after opening of the circuit breaker.

1.4 SAFETY FEATURES

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

b. It shall not be possible to interchange two circuit breakers of two different thermal ratings. For Draw-out breakers, an arrangement shall be provided to prevent rating mismatch between breaker and cradle.

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

d. The incoming panel accommodating ACB shall be provided with indicating lamps for ON-OFF positions, digital voltmeter and ammeter of size not less than 96 mm x 96 mm, selector switches, MCB for protection circuit and measuring instrument circuits.

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

f. Draw out breakers should not close unless in distinct Service/Test/Isolated positions.

g. The insulation material used shall conform to Glow wire test as per IEC60695.

h. The ACB shall provide in built electrical and mechanical anti-pumping.

j. All EDO ACB`s Shall have Ready to Close Contact to ensure that the ACB gets a command only when it is ready to close for applications of Remote Control, AMF, Synchronization and Auto Source Change Over Systems.

2. MOULDED CASE CIRCUIT BREAKER (MCCB)

The MCCB should be current limiting type with trip time of less than 10 msec under short circuit conditions. The MCCB should be either 3 or 4 poles as specified. The circuit breakers shall be for continuous rating and service short Circuit Breaking capacity (Ics) shall be as specified on the single line diagram and should be equal to the Ultimate breaking capacity (Icu) and short circuit withstand values (Icw) for 1 sec. MCCB shall comply with the requirements of the relevant standards IEC 60947-2 and should have test certificates for Breaking capacities from independent test authorities or any accredited international lab.

MCCB shall comprise of Quick Make -break switching mechanism, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses.

The breaking capacity of MCCB shall be as specified in the single line diagram / in the schedule of quantities/ as required for the application. The rated service breaking capacity (Ics) should be equal to rated ultimate breaking capacities (Icu). MCCB's for motor application should be selected in line with Type-2 Co-ordination as per IEC-60947-2, 1989.

The breaker as supplied with ROM should meet IP54 degree of protection.

a. Current Limiting & Coordination

- The MCCB shall employ maintenance free minimum let-through energies and capable of achieving discrimination up to the full short circuit capacity of the downstream MCCB. **The manufacturer shall provide both the discrimination tables and let-through energy curves for all.**

Protection Functions

- MCCB's with ratings up to 250 A shall be equipped with Thermal-magnetic (thermal for overload and magnetic for short-circuit protection) trip units.
- Microprocessor MCCB's with ratings above 250A and above shall be equipped with microprocessor-based trip units.
- Microprocessor and thermal-magnetic trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorized access to the settings.
- Microprocessor trip units shall comply with appendix F of IEC 60947-2 standard (measurement of rms current values, electromagnetic compatibility, etc.).
- Protection settings shall apply to all poles of circuit breaker.
- All Microprocessor components shall withstand temperatures up to 125 °C.

b. Testing

- Original test certificate of the MCCB as per IEC 60947-1 &2 shall be furnished.
- Pre-commissioning tests on the switch board panel incorporating the MCCB shall be done as per standard specifications.

c. Interlocking

Moulded, case circuit breakers shall be provided with the following interlocking devices for interlocking the door of a switch board.

i. Handle interlock to prevent unnecessary manipulations of the breaker.
ii. Door interlock to prevent the door being opened when the breaker is in ON position.
iii. Defeat-interlocking device to open the door even if the breaker is in ON position.

- The MCCB shall be current limiting type and comprise of quick make – Break switching mechanism. MCCB's shall be capable of defined variable overload adjustment.

- All MCCB with microprocessor-based release unit, the protection shall be adjustable Overload, Short circuit and earth fault protection with time delay.
- The trip command shall override all other commands.

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 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 IEC898-1995. Miniature circuit breakers shall be quick make and break type for 240/415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCB's shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCB's shall be classified (B, C, D) as per their Tripping Characteristic curves defined by

the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IEC and the manufacturer shall publish the values. MCB shall ensure complete electrical isolation & downstream circuit or equipment when the MCB is switched OFF.

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

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

For computers / UPS circuits	:	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)

a. System of Operation

Residual Current Circuit Breaker shall confirm to IEC 61008.RCCB shall work on the principle of core balance transformer. The incoming shall pass through the torroidal core transformer. As long as the currents in the phase and neutral shall be the same, no electro motive 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 shall cause a current to be generated in the secondary winding, this current shall be fed to a highly sensitive miniature relay, which shall trip the circuit if the earth leakage current exceeds a predetermined critical value. RCCB shall be current operated independent of the line voltage, current sensitivity shall be of 100 mA at 240/415 volts AC and shall have a minimum of 20,000 electrical operations.

b. Mechanical Operation

The moving contacts of the phases shall be mounted on a common bridge, actuated by a rugged toggle mechanism. Hence, the closing /opening of all the three phases shall occur simultaneously. This also shall ensure simultaneous opening of all the contacts under tripping conditions.

c. Neutral Advance Feature

The neutral moving contact shall be so mounted on the common bridge that, at the time of closing, the neutral shall make contact first before the phases; and at the time of opening, the neutral shall breaks last after allowing the phases to open first. This is an important safety feature which is also required by regulations.

d. Testing Provision

A test device shall be incorporated to check the integrity of the earth leakage detection system and the tripping mechanism. When the unit is connected to service, pressing the test knob shall trip the ELCB / RCCB and the operating handle shall move to the "OFF" position.

6. METERS

a. All voltmeters and indicating lamps shall be protected through MCB's.
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 International 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 measurement 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 International 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.

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 up to 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 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" color 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.

SUB-HEAD: H. CONSTRUCTION FEATURES OF LOW VOLTAGE MAIN AND SUB DISTRIBUTION BOARDS / PANELS/SWITCH BOARDS/ METER BOARDS/ACB ISOLATOR PANELS & GENERAL NOTES FOR PANELS & SWITCH BOARDS

GENERAL SPECIFICATIONS

Main & Sub Distribution Boards shall be classified as FBA (Factory Built Assemblies) as per IEC: 60439 Part-I of Cubicle type, Sheet steel clad, Totally enclosed, Dust & Vermin proof, Indoor 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: As approved

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

PARTITIONS: 1.6MM
Normal Indoor Application: CRCA
Outdoor Application: GI
Sheet Type: PN02/ Equivalent as approved
Sheet Make: 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: 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 & Lift well Pressurization Fan Panel (If Indoors)

IP: 54 for Indoor Application

- Plumbing Panel
- Fire Pump Panel
- STP Panel
- AC 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)

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 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

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 codes. Phase sequences and polarity to be followed as per 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 IEC

WIRING IDENTIFICATION
Computerized ferrule on both ends as per IEC

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 feeder 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.
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.

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

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.

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.
- 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 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: I. HT CABLE 11 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 International Standard Specifications and cable manufacturer's instructions.

2. Specification of 11KV grade Single/Multicore XLPE insulated PVC sheathed Aluminium / Copper conductor Armoured / Unarmoured cables shall be as per BSI/NBS:

a. Conductor :

- Material : Aluminium / Copper
- Shape : Stranded compacted circular aluminium / copper as per IEC.
- 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 : PVC type ST-2
h. Colour of sheath : Black

3. TESTS

Cables shall be type tested and routine tested in accordance with IEC:

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 BSI/NBS Standards & Codes.
Sufficient cable loops to be left at both the cable ends.

SUB-HEAD: J. **HT 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 in	-	350 MVA / 500 MVA at 11 KV for 3 sec or as specified in the B.O.Q

2. Site conditions climatic conditions

Ambient temperature	-	45^{o} maximum
	-	0^{o} minimum

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

3. Standard

Unless otherwise stated below HT switchboard shall conform to relevant International 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-4X 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-4X**
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 / 500 MVA at 11 kV for 3 sec.

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.

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.

11.2 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.

12 Terminals

All the cable terminations shall be at the rear side of the panel in adequate length for connecting the cable.

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 transformer to be provided.

13.3 Master trip relay to be provided.

14 Instrument transformer

14.1 The panel shall be provided with suitable but not less than 50 VA burden, accuracy class 1 potential transformers of ratio 11000/110 volts 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 in the incomer as called for in the BOQ:

15.1 Digital Ammeter within built for selector switch as called for in the outgoings.

15.2 Digital Trivector meter with MDI as called for in the B.O.Q.

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:-

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).

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. 8 window annunciation panel to be provided.

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 International 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.

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
Battery	:	12V7AH X2
Output Current	:	0-10Amps.(for Tripping).
Tripping	:	8-10(Depending on Battery 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 - Aluminium/ Copper.	
8	Type of CT's for Metering & Protection & CT Ratio & VA burden & Accuracy Class	
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: K. **TRANSFORMER (OIL TYPE)**

11kV / 433V ONAN (OIL TYPE) TRANSFORMERS WITH OFF LOAD TAP CHANGER / WITH ON LOAD TAP CHANGER

1. SCOPE

This section covers the detailed requirements regarding supply and installation of transformer as per specifications.

2. GENERAL CONSTRUCTION

a. The transformer shall comply with the following Standards as amended up to date:

1.	BSI/NBS	-	For power Transformers.
2.	BSI/NBS	-	For Installation and Maintenance of Transformers.
3.	BSI/NBS	-	For Bushings.
4.	BSI/NBS	-	For Current Transformers.
5.	BSI/NBS	-	For Guide for loading of oil immersed Transformers.
6.	BSI/NBS	-	For Transformer Oil.

b. Tanks and Radiators

Tanks shall be of MS plates and structural, electrically welded. The construction shall be robust and substantial, suitable for road/rail transport and to withstand vibration. Radiator tubes shall be electrical resistance welded type, round or elliptical or rectangular. They may be welded to the transformer tank or in case of very large sizes to separate detachable radiator banks connected through intermediate leak proof valves. Detachable radiator banks shall have top and bottom headers with flanged connections, with drain and vent fittings. Tanks shall be provided with lifting lugs and jacking lugs. Inspection hole with cover should also be provided for large transformers. Oil conservators shall be mounted on brackets attached to the top cover on tank. Dimensions of the conservator shall be such as to allow change in volume of oil due to change in temperature from 10^0C to 95^0C.

Tanks shall be thoroughly cleaned, degreased and sand blasted inside and outside. A coat of rust resistance primer shall immediately be given on outside surface. Inside surface shall be painted with oil resistance enamel paint. Tank and radiators shall be hydraulically pressure tested. Tanks shall also be tested for full vacuum. The procedure for testing shall be as follows:

i. Vacuum Test

The tanks designed for all vacuum shall be tested at an internal pressure of 3.33kN/m^2 (25mm of Hg) for one hour. The permanent deflection of flat plates after the vacuum has been released shall not exceed the value specified in Table 'A' without affecting the performance of the transformer.

ii. Pressure Test

One transformer tank of each size together with its radiators, conservator vessel and other fitting shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35kN/m^2 (0.35kg/sq.cm) whichever is lower measured at the base of the tank and will be maintained for one hour. The permanent deflection of flat plates after the excess pressure has been released shall not exceed the figure specified in Table' A.

TABLE 'A'

Horizontal length of **Flat plate (in mm)**	*Permanent deflection* **(in mm)**
Upto and including 750	5.0
750 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.5
2501 to 3000	16.0
Above 3000	19.0

c. Cores

Cores shall be built from cold rolled grain-oriented silicone steel laminations. Suitable high temperature resistance, oil proof, and adherent coating materials shall insulate the core laminations from each other. Core clamps and clamping bolts shall be heavily insulated from the core laminations.

The insulations of core bolt shall be minimum of class 'A'. The bottom and top frames shall be connected with the tie rods to make a complete structure rigid for carrying the weight of core-oil assembly without unduly stressing the laminations or windings. Lifting eyes shall be provided on the frame for removal of core assembly from the tank. Completed core shall be flash tested for insulation with 2500 Volts between the core and each of the clamps or core bolts (core being connected to earth).

All the core frames shall be bonded together with two metallic strips and connected to the tank for earthing to ensure earth return and operation of protective gear in the event of a fault. Lifting eyes (or any other provision) for lifting the core from the tank shall be provided.

d. Winding and Insulation

Winding shall be three phases with minimum class 'A' insulation. High conductivity electrolytic quality copper shall be used for winding. Windings shall be suitably braced to withstand the dynamic forces due to short circuit. Winding insulation shall be uniform and windings shall have full insulation.

Winding shall be individually vacuum dried before assembly as well as after assembly.

f. Insulation Oil

Insulation oil shall conform BSI/NBS standards. Transformers shall be supplied with initial fill of filtered oil.

g. Impedance

The transformer impedance shall be as per Codes.

3. MAXIMUM ALLOWABLE POWER TRANSFORMER LOSSES

Maximum allowable No load and Load losses for ONAN type distribution transformers with highest voltage for equipment shall be as per International Standard or less.

4. GENERAL REQUIREMENTS

The transformer shall be outdoor type as specified. Unless otherwise specified the transformer in addition shall have thermal and dynamic ability to withstand external short circuit.

5. TEMPERATURE RISE

The reference ambient temperatures assumed for the purpose of this specification are as follows: -

a. Maximum ambient air temperature 50°C
b. Maximum daily average ambient air temperature 40°C
c. Maximum yearly weighted average ambient temperature 32°C
d. Minimum ambient air temperature + 3°C

The temperature rise at the above conditions and at an altitude of 1000 meters above MSL shall not be exceeding as follows:

By resistance method 55°C
By thermometer 50°C.

6. RATING AND CAPACITY

Transformer shall be suitable for continuous operation and maximum capacity as given in the schedule of quantities. It shall be suitable to deliver full capacity continuously without any deration upto an ambient temperature of 50° C for outdoor application.

7. ON LOAD TAP CHANGING DEVICE (For Transformer with OLTC)

The tap changing device shall be provided on H.V. side, on circuit type, for tap position and locking arrangement at any of the tapping positions. It shall be designed for bi-directional operation and shall be of self-positioning type and shall have the following steps:

± 2.5%
± 5%
± 7.5%
± 10.0%
- 12.5%
- 15.0%

8. OFF LOAD TAP CHANGING DEVICE / TAPPINGS (For Transformer without OLTC)

The changing device shall be provided on H.V. side, off circuit type, externally hand operated with necessary indications for tap position and locking arrangement at any of the tapping positions. It shall be designed for bi-directional operation and shall be of self-positioning type and shall have the following steps:

± 2.5%

± 5%
± 7.5%

9. VOLTAGE RATIO

The transformer shall be suitable for a voltage ratio of 11kV / 433 Volts as specified in Schedule of Quantities.

10. VECTOR GROUP

The winding connection shall conform to vector group Dyn 11 unless otherwise specified.

11. COOLING

The transformer shall be oil immersed natural air-cooled type (ONAN). Transformer shall be suitable for completely outdoor duty / application.

12. ACCESSORIES

The transformer shall be single tank type with termination on bushings for outdoor installation or cable end box for indoor installation as specified on HV side. The MV side shall be suitable to receive cable suitable for full load current of the transformer.

13. FITTINGS

The transformer shall be complete with the following fittings:

a. Oil conservator with oil level indicator, minimum level marking and drain plug for all transformers.
b. Off circuit type tap change arrangement with position indicator and locking arrangement for all transformers.
c. Thermometer pocket with plug for all transformers.
d. 3 nos. 150mm dial type/stem type thermometer with metal guard dial type calibrated thermometer may have max. Temperature indicator and resetting device for all thermometers winding temperature alarm/trip and fitted in a marshaling box.
e. Lifting lugs for all transformers.
f. Bi-directional rollers.
g. Rating diagram and terminal marking plate for all transformers.
h. Explosion vent for transformers.
i. Additional Neutral separately brought out on a bushing for earthing for all transformers.
j. Earth terminals (2Nos) for body earthing for all transformers.
k. Valves for filtration, drainage and filling etc. with necessary plugs for all transformers.
l. Radiator assembly for all transformers.
m. Silica gel breather for all transformers.
n. Air release plug for all transformers.
o. First filling of oil shall be including make up fill during installation for all transformers.
p. Facility to connect up Buchholtz relay for all transformers.
q. Inspection cover on tank cover for access to terminal connections for all transformers.
r. Bushing terminations or cable box terminations as specified.
s. Necessary hardware clamps, lugs etc. for terminations on HV/MV etc. for all transformers.
t. Disconnecting chamber for H.T. and L.T.cable.
u. OLTC with RTCC Panel and necessary control cable (length 30M approx.) for transformer with OLTC provision

14. EXPLOSION VENT

Explosion vent or pressure relief device shall be provided of sufficient size for rapid release of any pressure that may be generated within the tank and which might result in damage to the equipment. The device shall operate at a static pressure less than the hydraulic test pressure for transformer tank. Means shall be provided to prevent the ingress of moisture and of such a design to prevent gas accumulation.

15. ACCOMMODATION FOR AUXILIARY APPARATUS

Restricted earth fault protection facilities shall be provided for the mounting of a neutral current transformer which shall be integral to Transformer. CT shall be 2000/5A, 15VA, class-PS with knee voltage 15V approx.

16. RATING AND DIAGRAM PLATES

The following plates shall be fixed to transformer tank in a visible position.

1. A rating plate of weather proof material bearing the data.

2. A diagram plate showing the internal connections and also the voltage vector relationship of the several windings and a plan view of the transformer giving the correct physical relationship of the terminals

17. JOINTS AND GASKETS

All gaskets used for making oil tight joints shall be of proven material such as granulated cork bounded with synthetic rubber gaskets of synthetic rubber.

18. GAS AND OIL ACTUATED (BUCHHOLTZ) RELAYS

Buchholtz relay shall be provided for the transformers.

Oil actuated relay equipment shall be double float type having contacts which close following oil surge or under incipient fault conditions.

Each gas and oil actuated relay shall be provided with a test cock to take a flexible pipe connection for checking the operation of the relay.

Where specified to allow gas to be collected at ground level, a pipe approximately 5mm inside diameter shall be connected to the release cock of the gas and oil actuated relay and brought down to a point approximately 1.25m above ground level, where it shall be terminated by a cock. A machined surface shall be provided on the top of each relay to facilitate the setting of the relays and to check the mounting angle in the pipe and the cross level of the relay.

The design of the relay mounting arrangements, the associated pipe work shall be such that mal-operation of the relays shall not take place under normal service. The pipe work shall be so arranged that all gas arising from the transformer shall pass through the gas and oil-actuated relay. The oil circuit through the relay shall not form a delivery path in parallel with any circulating oil pipe, nor shall it be tied into, or connected through, the pressure relief vent. Sharp bends in the pipe work shall be avoided.

All wiring connections, terminal boards, fuse and links etc. connected with gas-actuated relays shall be suitable for tropical atmosphere. Any wiring liable to be in contact with shall have oil resisting insulation and the bared ends of stranded wire shall be sealed together to

prevent creep age of oil along the wire. There shall be no possibility of oil entering connection boxes used for cables or wiring.

19. BUSDUCT / CABLE BOX

Cable box shall not be mounted on the tank covers. It shall be feasible to remove the tank covers for inspection during maintenance etc. without recourse to breaking the joints or disturbing the cables already terminated. Necessary removable links in oil approachable through inspection cover in tank etc. after lowering coil shall be provided for test purpose.

20. TESTS

The transformer shall be subjected to the following routine tests at the manufacturer's works before dispatch.

a. Measurement of winding resistance.
b. Voltage ratio, polarity and phase relationship.
c. Measurement of impedance voltage.
d. Load losses.
e. No load losses and no-load current.
f. Induced over voltage withstand.
g. Separate source voltage withstands.
h. Partial discharge 25PC upto 1.2 times the rated voltage.
i. Heat rum test of one transformer, the quoted rate for the transformer shall include all routine tests to be carried out at the manufacturer's works and all routine tests to be carried out at site as per specifications.

21. Pre-commissioning Tests.

1) General inspection
   a) Control and relay panels, etc.
   b) Junction boxes and marshalling kiosks.

2) Secondary injection on all transformer protection relays.

3) Primary injection
   a) Tests on operation and stability of earth
   (Also, to be repeated at fault relays on high voltage side.
   the end of all other Commissioning tests)
   b) Tests on over current relays on low voltage side.
   c) Tests on operation and stability of earth fault relays on low voltage side.
   d) Tests on operation of standby earth fault relays on low voltage side.
   e) Tests on overcurrent relay on high voltage Side (when current transformers are not in transformer bushings).
   f) Voltage compensation.

4) Ratio tests
   a) With 415V applied on high-voltage side, Measure the voltage between all phases on the low-voltage side for every tap position.
   b) To check phasing, measure volts: A to a,b and c

B to a,b and c
C to a,b and c

Where A, B and C (or R, Y, B) are the terminals of three phases on high voltage side and a, b and c are the corresponding terminals on low voltage side.

c) Magnetic balance test.

5) Tripping tests
   a) High voltage.
   b) Low voltage.
   c) Intertripping tests.
   d) Winding temperature trips.

6) Calibrate earthing resistance

7) Tap changing tests to check mechanism, Indication, buzzer, lamp,etc.

6) Insulation tests
   a) On high and low voltage windings.
   b) On current and voltage transformers, circuits, etc.

9) See that neutral earthing switches are closed before making alive.

10) Check Transformers on equal taps before Switching in
   a) For Transformer in a bank
   b) For Transformers in a parallel

9) Set down relays before closing in advice control

12) Load tests
   a) Voltmeter, ammeters, etc., on both high and low voltage sides.
   b) Over current.
   b) No spill in high voltage star point.
   c) No creeping of contacts on both high and low voltage earth fault relays.
   d) Voltage on relays.

13) Advice control of any new Equipment commissioned.

14) Low voltage excitation current.

15) Single phase, magnetic balance test.

The power frequency test voltage for the secondary winding shall be 2.5kV R.M.S. The transformer shall be charged only after the tests are conducted and approval of local authorities is obtained.

TECHNICAL DATA SHEETS

Data sheet for Transformers

S.NO.	SHORT DESCRIPTION	QUOTED DATA	AS PER TENDER
1.0	Make	-	
2.0	Service / Duty	-	
3.0	Type		
	a. Dry Type		
	b. Oil Type		
4.0	Installation		
	a. Indoor		
	b. Outdoor		
5.0	Protection class of enclosure (IP Rating)		
6.0	kVA rating	-	
	a. @45ºC Ambient for Indoor Type		
	b. @50ºC Ambient for Outdoor Type		
7.0	Rated voltage		
	a. HV	-	
	b. LV	-	
8.0	Rated frequency (Hz)	-	
9.0	Max. Temperature Rise	-	
10.0	Connections		
	a. HV	-	
	b. LV	-	
11.0	Tapping		
	a. Range	-	
	b. Tap Steps	-	
12.0	Tap Changing Mechanism		
	a. Without OLTC (off circuit)		
	b. With OLTC		
13.0	No load loss on rated voltage & frequency (Watt)	-	
14.0	Load loss at rated voltage	-	

15.0 Type of cooling -

16.0 Insulation class -

17.0 Terminal arrangement
(Cable box/ Bus ducts)
a. HV -
b. LV -

18.0 Impedance -

19.0 Total weight of transformer -
a. Wt. of copper Winding -
b. Wt. of Tank & fittings -
c. Total Weight. -

20.0 Overall dimensions of the transformers
a. Length (mm) -
b. Width (mm) -
c. Height (mm) -

21.0 Applicable standard -

22.0 Regulation of Transformer

a. At 0.8 power factor -
b. At unit power factor -

23.0 Foundation Detail -

24.0 Efficiencies at unit power factor and 0.8 power factor at 100%, 75%, 60% and 50% load.

a. At Unit Power Factor

(i) At 100% load -
(ii) At 75% load -
(iii) At 60% load -
(iv) At 50% load -

b. At 0.8 Power Factor

(i) At 100% load -
(ii) At 75% load -
(iii) At 60% load -
(iv) At 50% load -

25.0 Load at which maximum efficiency occurs -

26.0 Maximum efficiency at above load.-

27.0 Neutral current of transformer for - restricted earth fault protection.

28.0 Fitting and accessories - (Furnish a Complete list)

SUB-HEAD: L. <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: M. LIGHTNING PROTECTION SYSTEM (AS PER BSI/NBS CODES):

1. INTRODUCTION

Protection of buildings against lightning shall generally be done in accordance with BSI/NBS. A brief of the same is given below for guidance. Protection of special structures like trees, livestock in fields, structures supporting overhead lines, structures with highly combustible roof etc. shall be strictly done in accordance with BSI/NBS.

2. PRINCIPLE OF PROTECTION

The principle for protection of building against lightning is to provide a conducting path between earth and the atmosphere above building through which lightning discharge may enter the earth without causing damage to the building. If adequately earthed metal parts of proper proportions are provided and spread properly on and around the building, damage can be largely prevented.

The required conditions of protection are generally met by placing all the air terminals whether in the form of vertical finials or horizontal conductors, on the upper most part of the buildings or its projections with lightning conductors connecting the air terminals with each other and to the earth.

3. ZONE OF PROTECTION & ANGLE OF PROTECTION

The Zone of protection of a lightning conductor denotes the space within which a lightning conductor provides protection against a direct lightning stroke by diverting the stroke to it. For a single vertical conductor, this zone is described as a cone with its apex at the highest point of the conductor and with an angle, called as protective angle, between the side of the cone and the conductor. In general, for the purpose of providing an acceptable degree of protection the protective angle of any single component part of an air termination network, namely, either one vertical or one horizontal conductor is considered to be 45^{o}.Between two or more vertical conductors of equal height spaced at a distance not exceeding twice their height, the equivalent protective angle within the space bounded by the air terminations may be taken as 60^{o} to the vertical, while the protective angle away from the conductors is still taken as 45^{o} to the verticals.

4. NUMBER OF DOWN CONDUCTORS

The minimum numbers of down conductors be decided on the following consideration:

a) A structure having a base area not exceeding 100 m^2 need have only 1 (one) down conductor, except when built on hard rock where specialist advise be sought, or where excess for testing is difficult.

b) For structure having a base area exceeding 100 m^2, the number of down conductors should be at least smaller of the following

   i. One plus an additional one for each 300 m^2, or a part thereof, in excess of the first 100 m^2.
   ii. One for each 30 m of perimeter of the structure protected.

iii. Minimum two down conductors should, preferably, be provided.
iv. At least two down conductors will be required for testing.

5. (a) MATERIALS AND DIMENSIONS

The materials of lightning conductors, down conductors, earth termination etc. of the protective system shall be reliably resistant to corrosion or be adequately protected against corrosion. The materials recommended are: (a) *Copper*: Solid or flat copper strip of 98% conductivity conforming to relevant BSI. Specifications shall be used. (b) *Copper Clad Steel*: Copper clad steel with copper covering permanently and effectively welded to the steel core shall be used. The proportion of copper and steel shall be such that the conductance of the material is not less than 30% of conductance of the solid copper of the same total cross-sectional area. (c) *Galvanized Steel*: Steel thoroughly protected against corrosion by zinc coating shall be used. (d) Aluminum: Aluminum 99% pure and with sufficient mechanical strength and protected against corrosion shall be used.

Aluminum should not be used underground or in direct contact with walls.

Lightning conductor shall be secured at not more than 1 meter for horizontal run and 750 mm for vertical run by stainless steel fastener and standard copper clamps.

All Air Terminations shall be of G.I. and all down conductors shall be of G.I. or aluminum except where the atmospheric conditions necessitate the use of copper or copper clad steel for air terminations and down conductors.

Each down conductor shall be provided with testing point at a height not inviting unauthorized interference but convenient for use when testing. No connection, other than one direct to an earth electrode, shall be made below a testing point. Testing points shall be of G.I.

5(b) i. Minimum size of down conductor shall be: 25 mm x 3 mm GI (preferred shall be 25mm x 6mm GI from mechanical strength point of view).

ii. Minimum size of earth conductor shall be: 32 mm x 6 mm GI

iii. **Horizontal Ring:** Horizontal Ring of size of 25 mm x 3 mm GI strip / tape be provided on parapet connecting all down conductors and arrestors GI strip / tape should be fixed with suitable saddles / steppe with a maximum spacing of 600 mm (preferred shall be 25mm x 6mm GI from mechanical strength point of view).

iv. **Earth Ring:** All earth electrodes shall be connected to earth ring of 32 x 6 mm GI strip buried minimum 0.5 meter below ground level and 2 meters away from building foundation.

v. **Testing Joint:** Testing joint has to be provided on each down conductor at a height of 1.8-meter ground level.

Minimum size of jointing strip should be 85 mm with minimum overlap of 32 mm spacing fixed with 2 nos. GI bolt 6 mm x 25 mm with check nuts.

Minimum spacing between down conductor and earth conductor shall be 20 mm.

vi. **Number of Arrestors:** It should be calculated w.r.t. plan of top floor and plan of building on ground in a way that both are covered under ZONE of protection with angle of protection as specified (45° - 60°).

vii. Lift shaft should be bonded as per Codes.

viii. Angle of protection of horizontal and vertical arrestors / conductors is same.

ix. Size of down conductor / earth conductor remains same for GI / copper.

x. All arrestors should be connected to Air Termination (fixed on percept) through two connections on different sides of ring using covering two different down conductors.

xi. If resistance of earth conductor either of any of earth electrode or of combined network increases more than 2 Ω, than extra earth electrode be added till the Resistance become less than 2 Ω.

xii. Reinforcement in concrete structure can be used as down conductors but, in that case,

a) Details should be decided at design level.

b) Metal Bars of reinforced structure cast in site should be welded together. However, if it is not feasible than at least they should be tied together, with metallic binding wire at crossing points, firmly.

c) This should be provided for both vertical and vertical bars and horizontal to vertical bars.

xiii. Lighting protecting system must not be connected to pre-stressed concrete members.

6. DESIGN CONSIDERATIONS

When designing and installing lightning conductors, the following items should be taken into consideration:

a) The entire lightning protective system should be mechanically strong to withstand the mechanical forces produced in case of a lightning stroke.

b) The lightning protective system should be so installed that it does not spoil the architectural or aesthetic beauty of the buildings.

c) For the purpose of lightning protection, the vertical and horizontal conductors are considered equivalent and the use of pointed air terminations or vertical finals is, therefore, not regarded as essential. An air termination may consist of a vertical conductor, a single horizontal conductor or a system of horizontal and vertical conductors for the protection of the building.

d) A vertical air termination where provided need not have more than one point and shall project at least 30 cms. above the project, salient point or network on which it is fixed.

e) Horizontal air terminations should be so interconnected that no part of the roof is more than 9m away from the nearest horizontal termination along the outer perimeter of the roof is used. For a roof of larger area, a network of parallel horizontal conductors shall be installed.

f) Horizontal air terminations should be coursed along contours such as ridges, parapets and edges of flat roof, and where necessary over flat surfaces in such a way as to join each air termination to the rest and should themselves form a closed network.

g) All metallic finials, chimneys, ducts, vent pipes, railings, gutters, metallic flagstaff etc. on or above the main surface of the roof of the structure shall be bonded to, and form part of, the air termination network. If portions of a structure vary considerably in height, any necessary air termination or air termination network of the lower portions should in addition to their own conductors, be bonded to the down conductors of the taller portions.

h) All air terminals shall be effectively secured against overturning either by attachment to the object to be protected or by means of substantial braces and fixings which shall be permanently and rigidly attached to the building. The method and nature of the fixings should be simple, solid and permanent, due attention being given to climatic conditions and possible corrosion.

7. DOWN CONDUCTORS

a) Down conductors should be distributed round the outside walls of the structure. They shall preferably be run along the corners and other projections; due consideration being given to the location of air terminations and earth terminations. Lift shafts shall not be used for fixing down conductors.

b) Metal pipes leading rainwater from the roof to the ground may be connected to the down conductors but cannot replace them. Such connections shall have disconnecting joints.

c) In deciding on the routing of the down conductor, its accessibility for inspection, testing and maintenance should be taken into consideration.

8. JOINTS AND BONDS

The lightning protective system shall have as few joints in it as possible. Wherever joints in the down conductor above ground level are necessary they shall be mechanically and electrically effective. In the down conductor below ground level there shall be no joints. The joints may be welded. The bonding of the drain water pipe shall have a cross sectional area not less than that employed for the main conductors. Gas pipe, however, in no case shall be bonded to the earth termination system.

9. FASTENERS

Conductors shall be securely attached to the building or other object to be protected by fasteners, which shall be substantial in construction, not subject to breakage and shall be of galvanized steel or other suitable materials with suitable precautions to avoid corrosion. The lightning conductors shall be secured at not more than 1.0 m apart for horizontal run and 0.75 m for vertical run.

10. EARTH TERMINATIONS

Each down conductors shall have an independent earth pit. The interconnection of all the earth termination shall be preferable. It should be capable of isolation for testing purposes by 'testing joints' of G.I. provided in suitable enclosures.

11. EARTH ELECTRODE

Earth electrodes shall be constructed and installed in accordance with NBS/BSI.

The whole of the lightning protective system should have a combined resistance to earth not exceeding 2 ohms before any bonding has been affected to metal in or on a structure or to surface below ground.

Important Note :

Follow relevant BSI codes & NBS in totality for Design and Installation of Lightning Arrestor system.

SUB-HEAD: N. **TESTING & COMMISSIONING**

After completion of erection works before equipment is charged, the following minimum test shall be carried out. All tests shall be recorded in the format as approved by Architect/Consultant /PMC / Owner besides the test mentioned below any other tests specified by the local authority shall also be carried out. All tools and calibrated instruments for testing, labour, materials and incidentals necessary, to conduct the tests mentioned below shall be provided by the contractor at his own cost.

L.T. Switchgear & Distribution Boards.

Insulation resistance test of all the feeders by 500 V megger.

1. Test to Earth

This is made with all fuse links in place, all switches on and all lamps in position. The result must be not less than 50 megohms divided by number of outlets i.e., points and switch positions except that it need not exceed 1 megohm for the whole installations.

Control rheostats, heating and power appliances and electric signs may, if desired be disconnected for this test but if their insulation resistance must, in each case be not less than that given in the appropriate British Standard Specifications, or where there is no such specifications, be not less than half a megohm.

2. Test between Conductors

Where practicable, a test should be made between all conductors connected to one pole or phase conductor of the supply and all the conductors connected to the middle wire or neutral or the other pole or phase conductors of the supply.

For this test, all lamps should be removed and all switches on. The result again must be 50 megohms divided by the number of outlets i.e., points and switch positions but need not exceed 1 megohm for the whole installation.

Continuity test of all breakers, MCCB and fuse switch units.

Earth continuity test between various non-current carrying parts of equipment steel work et., and the earth bus provided in panels.

Operation of all meters and relays by secondary injection.

High voltage test 3 KV for 1 minute.

3. Cables

Insulation resistance test of all LT cables with 500 V megger.
Continuity test of all the cores and the armour.
Sheathing continuity test.
Earth test.

4. WIRING

4.1 Testing of Wiring

All wiring systems shall be tested for continuity of circuits, short circuits, and earthing after wiring is completed and before installation is energized.

Testing of Earth Continuity Path

The earth continuity conductor, metallic envelopes of cables shall be tested for electric continuity and the electrical resistance of the same, along with the earthing lead but excluding any added resistance or earth leakage circuit breaker, measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation, shall not exceed one ohm.

4.2 Insulation resistance Test

The insulation resistance shall be measured by applying between earth and the whole system to conductors or any sections thereof with all fuses in place and all switches closed, and except in earthed concentric wiring all lamps in position or both poles or the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure provided that it need not exceed 500 V for medium voltage circuits. Where the supply is derived from the three wire DC or poly phase AC system, the neutral pole of which is connected to earth direct or through added resistance, the working pressure shall be deemed to be that which is maintained between the phase conductor and the neutral.

The insulation resistance shall be measured between all conductors connected to one pole or phase conductor of all supply and all the conductors connected to the neutral or to the other pole or phase conductors of the supply with all lamps in position and switches in OFF position. The insulation resistance in mega ohm measured as above shall not be less than 50 mega ohm divided by the number of outlets or when PVC insulated cables are used for wiring 12.5 mega ohm divided by number of outlets.

4.3 Polarity test of switches

In two-wire installation, a test shall be made to verify that all switches in every circuit have been fitted in the same conductor throughout and such conductor shall be labelled or marked for connection to the phase conductor or to the non-earthed conductor.

In a three wire or a four-wire installation, test shall be made to verify that every non-linked single pole switch is fitted in a conductor, which is labelled or marked for connection to one of the phase conductors of the supply.

SUB-HEAD: O. UPS SYSTEM

1.0 General

1.1 Summary

The units wi*l* have state-of-the-art technology with high degree of reliability in operation for continuous operation 24 hrs. and 365 days a 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.

In case of IGBT Rectifier Option not available than the following Options only can be offered and vendor to ensure the technical /commercials are strictly in line with the same

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.

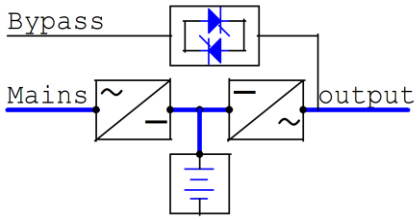
2.0 Modes of Operation

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.

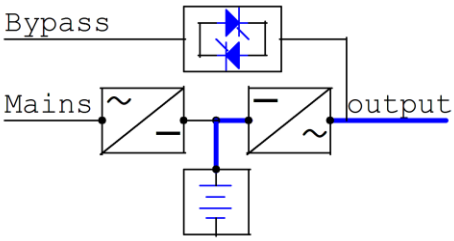


(A)

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.



(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)

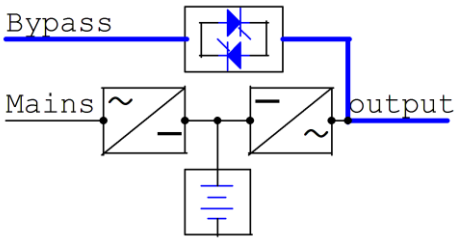
The system does not provide redundancy. The inverter of the UPS shall supply the load. The automatic bypass of UPS unit shall be connected to the same bypass AC source.

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.



(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.

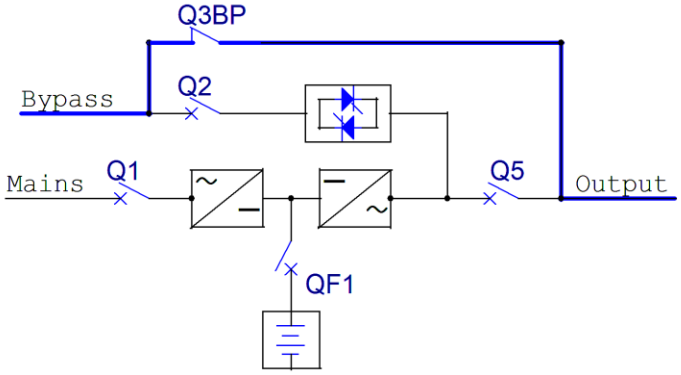


Fig. –2(D)

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. 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 **1 x 100KVA + 1x60 kVA** at a power factor of 0.8.
The UPS system shall be made up of 1 UPS unit, having a power rating of **1 x 100KVA + 1x60 kVA.**
There shall be **1 x 100KVA + 1x60 kVA** units operating independently, with independent 30 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 ≤ 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.

4. SYSTEM DESCRIPTION

4.1 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 **1x 100KVA + 1x60 kVA** at 0.8 lagging power factor.

4.2 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 compiled 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

5 ENVIRONMENTAL CONDITION

5.1 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.

6. 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.

6.1 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.

6.2 Quality Assurance

6.3 Manufacturer Qualifications

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

6.4 Factory Testing

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

7.0 PRODUCT

7.1 Fabrication

7.1 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.

7.2 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.

7.3 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.

8. Components

8.1 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 ensure that the DC output of the rectifier/charger will meet the input requirements of the inverter. The inverter shall be able to operate from the rectifier/charger with the battery disconnected.

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.

8.2 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.

8.3 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 undervoltage
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).

8.4 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.

8.5 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.

9.0 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

9.1. 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 control gear 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 latest standard.

E. Ecological environment:

- Manufacturing in compliance with standard.

F. Acoustic noise

- As per Local Sound power levels.
- EN 27779: Measurement of airborne noise emitted by computer and business equipment.

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	**1 x 100KVA + 1x60 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 drops 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	

S.No	Description	To be filled by Tenderer
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	
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	

S.No	Description	To be filled by Tenderer
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 P: INTELLIGENT REPORTING FIRE DETECTION SYSTEM

GENERAL

DESCRIPTION:

This section of the specification includes the furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Fire Alarm Control Panel (FACP), auxiliary control devices, annunciators, and wiring as shown on the drawings and specified herein.

The fire alarm system shall comply with requirements of NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.

The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.

SCOPE:

A new intelligent reporting, microprocessor-controlled fire detection system shall be installed in accordance to the project specifications and drawings.

Basic Performance:

Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Style 6 (Class A) Signaling Line Circuits (SLC).

Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D) as part of an addressable device connected by the SLC Circuit.

Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z) as part of an addressable device connected by the SLC Circuit.

On Style 6 or 7 (Class A) configurations a single ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.

Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.

NAC speaker circuits shall be arranged such that there is a minimum of one speaker circuit per floor of the building or smoke zone whichever is greater.

Audio amplifiers and tone generating equipment shall be electrically supervised for normal and abnormal conditions.

NAC speaker circuits and control equipment shall be arranged such that loss of any one (1) speaker circuit will not cause the loss of any other speaker circuit in the system.

Two-way telephone communication circuits shall be supervised for open and short circuit conditions.

DRAWINGS & TECHNICAL SUBMITTALS

General:

Two copies of all submittals shall be submitted to the Architect/Engineer for review.

All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality. Equivalent compatible UL-listed equipment from other manufacturers may be substituted for the specified equipment as long as the minimum standards are met.

For equipment other than that specified, the contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment.

Shop Drawings:

Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.

Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.

Show annunciator layout, configurations, and terminations.

Manuals:

Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets.

Wiring diagrams shall indicate internal wiring for each device and the interconnections between the items of equipment.

Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.

Software Modifications

Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.

Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and

changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site.

Certifications:

Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of the installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.

WARRANTY:

All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this one-year period shall be included in the submittal bid.

POST CONTRACT MAINTENANCE :

Complete maintenance and repair service for the fire alarm system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of five (5) years after expiration of the guaranty.

As part of the bid/proposal, include a quote for a maintenance contract to provide all maintenance, tests, and repairs described below. Include also a quote for unscheduled maintenance/repairs, including hourly rates for technicians trained on this equipment, and response travel costs for each year of the maintenance period. Submittals that do not identify all post contract maintenance costs will not be accepted. Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty.

Maintenance and testing shall be on a semiannual basis or as required by the AHJ. A preventive maintenance schedule shall be provided by the contractor describing the protocol for preventive maintenance. The schedule shall include:

Systematic examination, adjustment and cleaning of all detectors, manual fire alarm stations, control panels, power supplies, relays, waterflow switches and all accessories of the fire alarm system.

Each circuit in the fire alarm system shall be tested semiannually.

Each smoke detector shall be tested in accordance with the requirements of NFPA 72 Chapter 7.

POST CONTRACT EXPANSIONS:
The contractor shall have the ability to provide parts and labor to expand the system specified, if so requested, for a period of five (5) years from the date of acceptance.

As part of the submittal, include a quotation for all parts and material, and all installation and test labor as needed to increase the number of intelligent or addressable devices by ten percent (10%). This quotation shall include intelligent smoke detectors, intelligent heat detectors, addressable manual stations, addressable monitor modules and addressable modules equal in number to one tenth of the number required to meet this specification (list actual quantity of each type).

The quotation shall include installation, test labor, and labor to reprogram the system for this 10% expansion. If additional FACP hardware is required, include the material and labor necessary to install this hardware.

Do not include cost of conduit or wire or the cost to install conduit or wire except for labor to make final connections at the FACP and at each intelligent addressable device. Do not include the cost of conventional peripherals or the cost of initiating devices or notification appliances connected to the addressable monitor/control modules.

Submittals that do not include this estimate of post contract expansion cost will not be accepted.

APPLICABLE STANDARDS AND SPECIFICATIONS:
The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards, if applicable.

National Fire Protection Association (NFPA) - USA:

NFPA 13	Sprinkler Systems
NFPA 16	Foam/Water Deluge and Spray Systems
NFPA 17	Dry Chemical Extinguishing Systems
NFPA 17A	Wet Chemical Extinguishing Systems
NFPA 2001	Clean Agent Extinguishing Systems
NFPA 72	National Fire Alarm Code
NFPA 76	Telecommunication Facilities
NFPA 101	Life Safety Code
NFPA 90A	Air conditioning & ventilation system
EN 54	European Standards

B. Underwriters Laboratories Inc. (UL) - USA:

UL 268	Smoke Detectors for Fire Protective Signaling Systems
UL 864	Control Units for Fire Protective Signaling Systems **9th Edition Listed**
UL 268	A Smoke Detectors for Duct Applications
UL 521	Heat Detectors for Fire Protective Signaling Systems
UL 464	Audible Signaling Appliances
UL 38	Manually Actuated Signaling Boxes
UL 346	Water flow Indicators for Fire Protective Signaling Systems
UL 1971	Visual Notification Appliances
UL 228	Door Holders

NATIONAL BUILDING CODES
DELHI FIRE CODES

The Video Display Terminal (VDT) shall comply with Swedish magnetic emission and X-radiation guidelines MPR 1990:10.

APPROVALS:

The system shall have proper listing and/or approval from the following nationally recognized agencies:

UL Underwriters Laboratories Inc **(9th Edition) /** EN 54

The fire alarm control panel shall meet UL Standard 864 9th Edition (Control Units).
The system shall be listed by the national agencies as suitable for extinguishing release applications.
The system shall support release of high- and low-pressure CO2.

PRODUCTS

EQUIPMENT AND MATERIAL, GENERAL:

All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protective signaling system, meeting the National Fire Alarm Code.

All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.

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

CONDUIT AND WIRE:

Conduit:

Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.

Where required, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross-sectional area where three or more cables are contained within a single conduit.

Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-29.

Wiring for 24-volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.

Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or back boxes, except where conduit entry is specified by the FACP manufacturer.

Conduit shall be 25mm minimum, 16G MS.

Wire:

All wires shall be of FRLS PVC insulated copper conductor as per BOQ

MAIN FIRE ALARM CONTROL PANEL OR NETWORK NODE:

The main FACP Central Console shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, panel modules including initiating circuits, control circuits, and notification appliance circuits, local and remote operator terminals, printers, annunciators, and other system-controlled devices.

1. In conjunction with intelligent Loop Control Modules and Loop Expander Modules, the main FACP shall perform the following functions:

a. Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.

b. Supervise all initiating signaling and notification circuits throughout the facility by way of connection to monitor and control modules.

c. Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed. In the event of CPU failure, all SLC loop modules shall fallback to degrade mode. Such degrade mode shall treat the corresponding SLC loop control modules and associated detection devices as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.

d. Visually and audibly annunciate any trouble, supervisory, security or alarm condition on operator's terminals, panel display, and annunciators.

2. When a fire alarm condition is detected and reported by one of the systems initiating devices or appliances, the following functions shall immediately occur:

a. The system alarm LED shall flash.

b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.

c. The 640 -character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.

e. All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

3. When a trouble condition is detected and reported by one of the systems initiating devices or appliances, the following functions shall immediately occur:

a. The system trouble LED shall flash.

b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.

c. The 640 -character backlit LCD display shall indicate all information associated with the trouble condition, including the type of trouble point and its location within the protected premises.

d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.

e. All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated system outputs (trouble notification appliances and/or relays) shall be activated.

4. When a supervisory condition is detected and reported by one of the systems initiating devices or appliances, the following functions shall immediately occur:

a. The system trouble LED shall flash.

b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.

c. The 640 -character backlit LCD display shall indicate all information associated with the supervisory condition, including the type of trouble point and its location within the protected premises.

d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.

e. All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.

5. When a security alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

a. The system security LED shall flash.

b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.

c. The 640 -character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.

e. All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

6. When a pre-alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

a. The system pre-alarm LED shall flash.

b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.

c. The 640-character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.

e. All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

Operator Control

Acknowledge Switch:

a. Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the LCD display to the next alarm or trouble condition. In addition, the FACP shall support Block Acknowledge to allow multiple trouble conditions to be acknowledged with a single depression of this switch.

b. Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.

Signal Silence Switch:

Depression of the Signal Silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition. The selection of notification circuits and relays that are silence able by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.

1. Drill Switch:
Depression of the Drill switch shall activate all programmed notification appliance circuits. The drill function shall latch until the panel is silenced or reset.

2. System Reset Switch:
Depression of the System Reset switch shall cause all electronically latched initiating devices to return to their normal condition. Initiating devices shall re-report if active. Active notification appliance circuits shall not silence upon Reset. Systems that de-activate and subsequently re-activate notification appliance circuits shall not be considered equal. All programmed Control-By-Event equations shall be re-evaluated after the reset sequence is

complete if the initiating condition has cleared. Non-latching trouble conditions shall not clear and re-report upon reset.

3. Lamp Test:
The Lamp Test switch shall activate all local system LEDs, light each segment of the liquid crystal display and display the panel software revision for service personal.

4. Scroll Display Keys:
There shall be Scroll Display keys for FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. Depression of the Scroll Display key shall display the next event in the selected queue allowing the operator to view events by type.

5. Print Screen:
Depression of the PRINT SCREEN switch shall send the information currently displayed on the 640character display to the printer.

System Capacity and General Operation:

1. The control panel shall be capable of expansion via up to 10 SLC modules. Each module shall support a maximum of 318 analog/Intelligent/addressable devices for a maximum system capacity of 3180 points. The system shall be capable of 3072 annunciation points per system regardless of the number of addressable devices.

2. The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit 640-character liquid crystal display, individual, color coded system status LEDs, and a QWERTY style alphanumeric keypad for the field programming and control of the fire alarm system. Said LCD shall also support graphic bit maps capable of displaying the company name and logo of either the owner or installing company / software programming.

3. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.

The FACP shall be able to provide the following software and hardware features:

a. Pre-signal and Positive Alarm Sequence: The system shall provide means to cause alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, a Positive Alarm Sequence selection shall be available that allows a 15-second time period for acknowledging an alarm signal from a fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local and remote outputs shall automatically activate immediately.

b. Smoke Detector Pre-alarm Indication at Control Panel: To obtain early warning of incipient or potential fire conditions, the system shall support a programmable option to determine system response to real-time detector sensing values above the programmed setting. Two levels of Pre-alarm indication shall be available at the control panel: alert and action.

c. Alert: It shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.

d. Action: If programmed for action, and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition. Sounder bases installed with either heat or smoke detectors shall automatically activate on action Pre-Alarm level, with general evacuation on alarm level.

e. The system shall support a detector response time to meet world annunciation requirements of less than 3 seconds.

f. Device Blink Control: Means shall be provided to turn off detector/module LED strobes for special areas.

g. NFPA 72 Smoke Detector Sensitivity Test: The system shall provide an automatic smoke detector test function that meets the requirements of NFPA 72.

h. Programmable Trouble Reminder: The system shall provide means to automatically initiate a reminder that troubles exist in the system. The reminder will appear on the system display and (if enabled) will sound a piezo alarm.

i. On-line or Off-line programming: The system shall provide means to allow panel programming either through an off-line software utility program away from the panel or while connected and on-line. The system shall also support upload and download of programmed database and panel executive system program to a Personal Computer/laptop.

j. History Events: The panel shall maintain a history file of the last 4000 events, each with a time and date stamp. History events shall include all alarms, troubles, operator actions, and programming entries. The control panels shall also maintain a 1000 event Alarm History buffer, which consists of the 1000 most recent alarm events from the 4000 event history file.

k. Smoke Control Modes: The system shall provide means to perform FSCS mode Smoke Control to meet NFPA-92A and 90B and HVAC mode to meet NFPA 90A.

l. The system shall provide means for all SLC devices on any SLC loop to be auto programmed into the system by specific address. The system shall recognize specific device type ID's and associate that ID with the corresponding address of the device.

m. Drill: The system shall support means to activate all silenceable fire output circuits in the event of a practice evacuation or "drill". If enabled for local control, the front panel switch shall be held for a minimum of 2 seconds prior to activating the drill function

n. Passwords and Users: The system shall support two password levels, master and user. Up to 9 user passwords shall be available, each of which may be assigned access to the programming change menus, the alter status menus, or both. Only the master password shall allow access to password change screens.

o. Block Acknowledge: The system shall support a block Acknowledge for Trouble Conditions

p. Sensitivity Adjust: The system shall provide Automatic Detector Sensitivity Adjust based on Occupancy schedules including a Holiday list of up to 15 days.

r. Environmental Drift Control: The system shall provide means for setting Environmental Drift Compensation by device. When a detector accumulates dust in the chamber and reaches an

unacceptable level but yet still below the allowed limit, the control panel shall indicate a maintenance alert warning. When the detector accumulates dust in the chamber above the allowed limit, the control panel shall indicate a maintenance urgent warning.

s. Custom Action Messages: The system shall provide means to enter up to 100 custom action messages of up to 160 characters each. It shall be possible to assign any of the 100 messages to any point.

t. Print Functions: The system shall provide means to obtain a variety of reports listing all event, alarm, trouble, supervisory, or security history. Additional reports shall be available for point activation for the last Walk Test performed, detector maintenance report containing the detector maintenance status of each installed addressable detector, all network parameters, all panel settings including broad cast time, event ordering, and block acknowledge, panel timer values for Auto Silence, Silence Inhibit, AC Fail Delay time and if enabled, Proprietary Reminder, and Remote Reminder timers, supervision settings for power supply and printers, all programmed logic equations, all custom action messages, all non-fire and output activations (if pre-programmed for logging) all active points filtered by alarms only, troubles only, supervisory alarms, pre-alarms, disabled points and activated points, all installed points filtered by SLC points, panel circuits, logic zones, annunciators, releasing zones, spal zones, and trouble zones.

u. Local Mode: If communication is lost to the central processor the system shall provide added survivability through the intelligent loop control modules. Inputs from devices connected to the SLC and loop control modules shall activate outputs on the same loop when the inputs and outputs have been set with point programming to participate in local mode or when the type codes are of the same type: that is, an input with a fire alarm type code shall activate an output with a fire alarm type code.

v. Resound based on type for security or supervisory: The system shall indicate a Security alarm when a monitor module point programmed with a security Type Code activates. If silenced alarms exist, a Security alarm will resound the panel sounder. The system shall indicate a Supervisory alarm when a monitor module point programmed with a supervisory Type Code activates. If there are silenced alarms, a Supervisory alarm will resound the panel sounder.

w. Read status preview - enabled and disabled points: Prior to re-enabling points, the system shall inform the user that a disabled device is in the alarm state. This shall provide notice that the device must be reset before the device is enabled thereby avoiding activation of the notification circuits.

x. Custom Graphics: When fitted with an LCD display, the panel shall permit uploading of a custom bit-mapped graphic to the display screen. Graphic shall display when all systems are normal.

y. Multi-Detector and Cooperating Detectors: The system shall provide means to link one detector to up to two detectors at other addresses on the same loop in cooperative multi-detector sensing. There shall be no requirement for sequential addresses on the detectors and the alarm event shall be a result or product of all cooperating detectors chamber readings.

z. Tracking/Latching Duct: The system shall support both tracking and latching duct detectors.

aa. ACTIVE EVENT: The system shall provide a Type ID called FIRE CONTROL for purposes of air-handling shutdown, which shall be intended to override normal operating automatic functions. Activation of a FIRE CONTROL point shall cause the control panel to (1) initiate the monitor module Control-by-Event, (2) send a message to the panel display, history buffer, installed printer and annunciators, (3) shall not light an indicator at the control panel, (4) Shall display ACTIVE on the LCD as well a display a FIRE CONTROL Type Code and other information specific to the device.

bb. NON-FIRE Alarm Module Reporting: A point with a type ID of NON-FIRE shall be available for use for energy management or other non-fire situations. NON-FIRE point operation shall not affect control panel operation nor shall it display a message at the panel LDC. Activation of a NON-FIRE point shall activate control by event logic but shall not cause any indication on the control panel.

cc. Security Monitor Points: The system shall provide means to monitor any point as a type security.

dd. One-Man Walk Test: The system shall provide both a basic and advanced walk test for testing the entire fire alarm system. The basic walk test shall allow a single operator to run audible tests on the panel. All logic equation automation shall be suspended during the test and while annunciators can be enabled for the test, all shall default to the disabled state. During an advanced walk test, field-supplied output point programming will react to input stimuli such as CBE and logic equations. When points are activated in advanced test mode, each initiating event shall latch the input. The advanced test shall be audible and shall be used for pull station verification, magnet activated tests on input devices, input and output device and wiring operation/verification.

ee. Control By Event Functions: CBE software functions shall provide means to program a variety of output responses based on various initiating events. The control panel shall operate CBE through lists of zones. A zone shall become listed when it is added to a point's zone map through point programming. Each input point such as detector, monitor module or panel circuit module shall support listing of up to 10 zones into its programmed zone map.

ff. Permitted zone types shall be general zone, releasing zone and special zone. Each output point (control module, panel circuit module) can support a list of up to 10 zones including general zone, logic zone, releasing zone and trouble zone. It shall be possible for output points to be assigned to list general alarm. Non-Alarm or Supervisory points shall not activate the general alarm zone.

gg. 1000 General Zones: The system shall support up to 1000 general purpose software zones for linking inputs to outputs. When an input device activates, any general zone programmed into that device's zone map will be active and any output device that has an active general zone in its map will be active. It shall also be possible to use general zone as arguments in logic equations.

hh. 1000 Logic Equations: The system shall support up to 1000 logic equations for AND, OR, NOT, ONLY1, ANYX, XZONE or RANGE operators that allow conditional I/O linking. When any logic equation becomes true, all output points mapped to the logic zone shall activate.

ii. 10 trouble equations per device: The system shall provide support for up to 10 trouble equations for each device, which shall permit programming parameters to be altered, based on specific fault conditions. If the trouble equation becomes true, all output points mapped to the trouble zone shall activate.

jj. Control-By-Time: A time-based logic function shall be available to delay an action for a specific period of time based upon a logic input with tracking feature. A latched version shall also be available. Another version of this shall permit activation on specific days of the week or year with ability to set and restore based on a 24-hour time schedule on any day of the week or year.

kk. Multiple agents releasing zones: The system shall support up to 10 releasing zones to protect against 10 independent hazards. Releasing zones shall provide up to three cross-zone with four abort options to satisfy any local jurisdiction requirements.

ll. Alarm Verification, by device, with timer and tally: The system shall provide a user-defined global software timer function that can be set for a specific detector or indicating panel module input. The timer function shall delay an alarm signal for a user-specified time period and the control panel shall ignore the alarm verification timer if another alarm is detected during the verification period. It shall also be possible to set a maximum verification count between 0 and 20 with the "0" setting producing no alarm verification. When the counter exceeds the threshold value entered, a trouble shall be generated to the panel.

Central Processing Unit

1. The Central Processing Unit shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the Central Processing Unit.

2. The Central Processing Unit shall contain and execute all control-by-event (including Boolean functions including but not limited to AND, OR, NOT, ANYx, and CROSSZONE) programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory, and shall not be lost with system primary and secondary power failure.

3. The Central Processing Unit shall also provide a real-time clock for time annotation, to the second, of all system events. The time-of-day and date shall not be lost if system primary and secondary power supplies fail.

4. The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.

5. Consistent with UL864, the CPU and associated equipment are to be protected so that voltage surges or line transients will not affect them.

6. Each peripheral device connected to the CPU shall be continuously scanned for proper operation. Data transmissions between the CPU and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equivalent error checking techniques.

7. The CPU shall provide an EIA-232 interface between the fire alarm control panel and the UL Listed Electronic Data Processing (EDP) peripherals.

8. The CPU shall provide two EIA-485 ports for the serial connection to annunciation and control subsystem components.

9. The EIA-232 serial output circuit shall be optically isolated to assure protection from earth ground.

10. The CPU shall provide one high-speed serial connection for support of network communication modules.

11. The CPU shall provide double pole relays for FIRE ALARM, SYSTEM TROUBLE, SUPERVISORY, and SECURITY. The SUPERVISORY and SECURITY relays shall provide selection for additional FIRE ALARM contacts.

Display

1. The system display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.

2. The display assembly shall contain, and display as required, custom alphanumeric labels for all intelligent detectors, addressable modules, and software zones.

3. The system display shall provide a 640-character backlit alphanumeric Liquid Crystal Display (LCD). It shall also provide ten Light-Emitting-Diodes (LEDs) that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM, SECURITY, SUPERVISORY, SYSTEM TROUBLE, OTHER EVENT, SIGNALS SILENCED, POINT DISABLED, and CPU FAILURE.

4. The system display shall provide a QWERTY style keypad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels with up to ten (one Master and nine User) passwords shall be accessible through the display interface assembly to prevent unauthorized system control or programming / software programming.

5. The system display shall include the following operator control switches: ACKNOWLEDGE, SIGNAL SILENCE, RESET, DRILL, and LAMP TEST. Additionally, the display interface shall allow scrolling of events by event type including, FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. A PRINT SCREEN button shall be provided for printing the event currently displayed on the 640character LCD.

Loop (Signaling Line Circuit) Control Module:

1. The Loop Control Module shall monitor and control a minimum of 318 intelligent addressable devices. This includes 159 intelligent detectors (Photoelectric, Thermal etc.) and 159 monitor or control modules.

2. The Loop Control Module shall contain its own microprocessor and shall be capable of operating in a local/degrade mode (any addressable device input shall be capable of activating any or all addressable device outputs) in the unlikely event of a failure in the main CPU.

3. The Loop Control Module shall provide power and communicate with all intelligent addressable detectors and modules on a single pair of wires. This SLC Loop shall be capable of operating as a NFPA Style 6 (Class B) circuit.

4. The SLC interface board shall be able to drive an NFPA Style 6 twisted shielded circuit up to 12,500 feet in length. The SLC Interface shall also be capable of driving an NFPA Style 6, no twist, no shield circuit up to 3,000/14,000 feet in length. In addition, SLC wiring shall meet the listing requirements for it to exit the building or structure. "T"-tapping shall be allowed in either case.

5. The SLC interface board shall receive analog or digital information from all intelligent detectors and shall process this information to determine any no. whether normal, alarm, or trouble conditions exist for that particular device. Each SLC Loop shall be isolated and equipped to annunciate an Earth Fault condition. The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic / by module detector testing and the automatic determination of detector maintenance requirements.

Enclosures:

1. The control panel shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.

2. The back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top.

3. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. For convenience, the door may be site configured for either right or left hand hinging.

4. The control unit shall be modular in structure for ease of installation, maintenance, and future expansion.

Power Supply:

1. The Addressable Main Power Supply shall operate on 240 VAC, 50 Hz, and shall provide all necessary power for the FACP.

2. The Addressable Main Power Supply shall provide sufficient power to the CPU, using a switching 24 VDC regulator and shall incorporate a battery charger for 24 hours of standby power using dual-rate charging techniques for fast battery recharge.

3. The Addressable Main Power Supply shall provide a battery charger for 24 hours of standby using dual-rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 25-200 amp-hours within a 48-hour period.

4. The Addressable Main Power Supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.

5. The Addressable Main Power Supply shall be power-limited per 1995 UL864 requirements.

System Circuit Supervision:

1. The FACP shall supervise all circuits to intelligent devices, annunciators and conventional peripherals and annunciate loss of communications with these devices. The CPU shall continuously scan above devices for proper system operation and upon loss of response from a device shall sound an audible trouble, indicate that device or devices are not responding and print the information in the history buffer and on a printer.

2. Sprinkler system valves, standpipe control valves, PIV and main gate valves shall be supervised for off-normal position.

Field Wiring Terminal Blocks:

All wiring terminal blocks shall be the plug-in/removable type and shall be capable of terminating up to 12 AWG wire. Terminal blocks that are permanently fixed to the PC board are not acceptable.

Printer

1. Printers shall be of the automatic type, printing code, time, date, location, category, and condition.

2. The printer shall provide hard-copy printout of all changes in status of the system and shall time-stamp such printouts with the current time-of-day and date. The printer shall be standard carriage with 80-characters per line and shall use standard pin-feed paper. The printer shall be enclosed in a separate cabinet suitable for placement on a desktop or table and UL, ULC listed. The printer shall communicate with the control using an interface complying with Electrical Industries Association standard EIA-232D. The printer power shall be 230 VAC @ 50 Hz.

3. Thermal printers are not acceptable.

4. The system shall have a strip printer capable of being mounted directly in the main FACP enclosure. Alarms shall be printed in easy-to-read RED, other messages, such as a trouble, shall be printed in BLACK. This printer shall receive power from the system power supply and shall operate via battery backup if AC mains are lost. The strip printer shall be UL 864 listed.

Field Programming

1. The system shall be programmable, configurable and expandable in the field with / without the need for special tools, laptop computers, or other electronic interface equipment. There shall be no firmware changes required to field modify the system time, point information, equations, or annunciator programming/information.

2. It shall be possible to program through the standard FACP keyboard all system functions / software.

3. All field defined programs shall be stored in non-volatile memory.

4. Two levels of password protection shall be provided in addition to a key-lock cabinet. One level shall be used for status level changes such as point/zone disable or manual on/off commands (Building Manager). A second (higher-level) shall be used for actual change of the life safety program (installer). These passwords shall be five (5) digits at a minimum. Upon entry of an invalid password for the third time within a one-minute time period an encrypted number shall be displayed. This number can be used as a reference for determining a forgotten password.

Specific System Operations

1. Smoke Detector Sensitivity Adjust: Software means shall be provided for adjusting the sensitivity of any or all analog intelligent smoke detectors in the system from the system keypad or from the keyboard of the video terminal. Sensitivity range shall be within the allowed UL window.

2. Alarm Verification: Each of the intelligent addressable Smoke Detectors in the system may independently selected and enable to be an alarm verified detector. The alarm verification function shall be programmable from 5 to 50 seconds and each detector shall be able to be selected for verification during the field programming of the system or any time after system turn on. Alarm verification shall not require any additional hardware to be added to the control panel. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.

3. System Point Operations:

a. Any addressable device in the system shall have the capability to be enabled or disabled through the system keypad or video terminal.
b. System output points shall be capable of being turned on or off from the system keypad or the video terminal.

4. Point Read: The system shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point shall be annunciated for the parameters listed:

    a. Device Status.
    b. Device Type.
    c. Custom Device Label.
    d. Software Zone Label.
    e. Device Zone Assignments.

f. Analog Detector Sensitivity.
g. All Program Parameters.

5. System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system statuses:

6. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 4000 system events. Each of these events will be stored, with time and date stamp, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed, one event at a time, and the actual number of activations may also be displayed and or printed.
   The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable.

7. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.
   If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular Intelligent Detector will be annunciated on the system display, and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

8. The system shall include the ability (programmable) to indicate a "pre-alarm" condition. This will be used to alert maintenance personal when a detector is at 80% of its alarm threshold in a 60 second period.

Signaling Line Circuits (SLC)

Each FACP or FACP network node shall support up to two SLCs. Each SLC interface shall provide power to and communicate with up to 159intelligent detectors (ionization, photoelectric or thermal) and 159/125 intelligent modules (monitor or control) for a loop capacity of 318devices. The addition of the optional second loop shall double the device capacity, supporting a total of 636 devices. Each SLC shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class A or B) wiring.

CPU shall receive analog information from all intelligent detectors to be processed to determine whether normal, alarm, pre-alarm, or trouble conditions exist for each detector. The software shall automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information shall also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.

Serial Interfaces

The system shall include two serial EIA-232 interfaces. Each interface shall be a means of connecting UL Listed Information Technology Equipment (ITE) peripherals.

One EIA-232 interface shall be used to connect an UL-Listed 40 or 80 column printer. Printers that are not UL-Listed are not considered acceptable substitutes.

One EIA-232 interface shall be used to connect a UL-listed CRT terminal. This interface shall include special protocol methods that allow off-site monitoring of the FACP over standard dial-up phone lines. This ancillary capability shall allow remote readout of all status information, including analog values, and shall not interfere with or degrade FACP operations when used. It shall allow remote FACP Acknowledge, Reset, or Signal Silence in this mode. It shall also allow adjustment of detector sensitivity and readout of the history file.

The system shall include an EIA-485 port for the serial connection of optional annunciators and remote LCD displays.

The EIA-485 interface may be used for network connection to a proprietary-receiving unit.

Digital Voice Command Center

The Digital Voice Command Center located with the FACP, shall contain all equipment required for all audio control, emergency telephone system control, signaling and supervisory functions. This shall include speaker zone indication and control, telephone circuit indication and control, digital voice units, microphone and main telephone handset.

Function: The Voice Command Center equipment shall perform the following functions:

Operate as a supervised multi-channel emergency voice communication system.

Operate as a two-way emergency telephone system control center.

Audibly and visually annunciate the active or trouble condition of every speaker circuit and emergency telephone circuit.

Audibly and visually annunciate any trouble condition for digital tone and voice units required for normal operation of the system.

Provide all-call Emergency Paging activities through activation of a single control switch.

As required, provide vectored paging control to specific audio zones via dedicated control switches.

Provide a factory recorded “library” of voice messages and tones in standard WAV. File format, which may be edited and saved on a PC running a current Windows® operating system.
Provide a software utility capable of off-line programming for the VCC operation and the audio message files. This utility shall support the creation of new programs as well as editing and saving existing program files. Uploading or downloading the VCC shall not inhibit the emergency operation of other nodes on the fire alarm network.

Support an optional mode of operation with four analog audio outputs capable of being used with UL 864 fire-listed analog audio amplifiers and SCL controlled switching.

The Digital Voice Command shall be modular in construction, and shall be capable of being field programmable without requiring the return of any components to the manufacturer and without requiring use of any external computers or other programming equipment.

The Digital Voice Command and associated equipment shall be protected against unusually high voltage surges or line transients.

Audio Amplifiers

The Audio Amplifiers will provide Audio Power (@70 Volts RMS) for distribution to speaker circuits.

Multiple audio amplifiers may be mounted in a single enclosure, either to supply incremental audio power, or to function as an automatically switched backup amplifier(s).

The audio amplifier shall include an integral power supply, and shall provide built-in LED indicators for the following conditions:

Earth Fault on DAP A (Digital Audio Port A)
Earth Fault on DAP B (Digital Audio Port B)
Audio Amplifier Failure Detected
Trouble
Active Alarm Bus input
Audio Detected on Aux Input A
Audio Detected on Aux Input B
Audio Detected on Fire Fighter's Telephone Riser
Receiving Audio from digital audio riser
Short circuit on speaker circuit 1
Short circuit on speaker circuit 2
Short circuit on speaker circuit 3
Short circuit on speaker circuit 4
Data Transmitted on DAP A
Data Received on DAP A
Data Transmitted on DAP B
Data Received on DAP B
Board failure
Active fiberoptic media connection on port A (fiberoptic media applications)
Active fiberoptic media connection on port B (fiberoptic media applications)
Power supply Earth Fault
Power supply 5V present
Power supply conditions – Brownout, High Battery, Low Battery, Charger Trouble
The audio amplifier shall provide the following built-in controls:
Amplifier Address Selection Switches
Signal Silence of communication loss annunciation
Reset
Level adjustment for background music
Enable/Disable for Earth Fault detection on DAP A
Enable/Disable for Earth Fault detection on DAP A
Switch for 2-wire/4-wire FFT riser

Adjustment of the correct audio level for the amplifier shall not require any special tools or test equipment.

Includes audio input and amplified output supervision, back up input, and automatic switch over function, (if primary amplifier should fail).

System shall be capable of backing up digital amplifiers.

Audio Message Generator (Prerecorded Voice)/Speaker Control:

Each initiating zone or intelligent device shall interface with an emergency voice communication system capable of transmitting a prerecorded voice message to all speakers in the building.

Actuation of any alarm initiating device shall cause a prerecorded message to sound over the speakers. The message shall be repeated four (4) times. Pre- and post-message tones shall be supported.

A built-in microphone shall be provided to allow paging through speaker circuits.

Speaker Switches/Indicators

The speaker circuit control switches/indicators shall include visual indication of active and trouble status for each speaker circuit in the system.

The speaker circuit control panel shall include switches to manually activate or deactivate each speaker circuit in the system.

Fire Fighters Telephone System

The emergency telephone circuit control panel shall include visual indication of active and trouble status for each telephone circuit in the system.

The telephone circuit control panel shall include switches to manually activate or deactivate each telephone circuit in the system.

Waterflow Operation

An alarm from a waterflow detection device shall activate the appropriate alarm message on the main panel display; turn on all programmed notification appliance circuits and shall not be affected by the signal silence switch.
Supervisory Operation

An alarm from a supervisory device shall cause the appropriate indication on the system display, light a common supervisory LED, but will not cause the system to enter the trouble mode.

Signal Silence Operation

The FACP shall have the ability to program each output circuit (notification, relay, speaker etc) to deactivate upon depression of the signal silence switch.

Non-Alarm Input Operation

Any addressable initiating device in the system may be used as a non-alarm input to monitor normally open contact type devices. Non-alarm functions are a lower priority than fire alarm initiating devices.

SYSTEM COMPONENTS:

Printer

The printer shall provide hard-copy printout of all changes in status of the system and shall time-stamp such printouts with the current time-of-day and date. The printer shall be standard carriage with 80-characters per line and shall use standard pin-feed paper. The printer shall be enclosed in a separate cabinet suitable for placement on a desktop or table. The printer shall communicate with the control panel using an interface complying with Electrical Industries Association standard EIA-232D. Power to the printer shall be 230 VAC @ 50 Hz.

The system shall have a strip printer capable of being mounted directly in the main FACP enclosure. Alarms shall be printed in easy-to-read RED, other messages, such as a trouble, shall be printed in BLACK. This printer shall receive power from the system power supply and shall operate via battery back-up if AC mains are lost. The strip printer shall be UL 864 listed.

Repeater Panel (RP)

A repeater panel shall be provided to display all system intelligent points. The RP shall be capable of displaying all information for all 10,000 possible points on the network. Network display devices, which are only capable of displaying a subset of network points, shall not be suitable substitutes.

The RP shall include a minimum of 640 characters, backlit by a long-life, solid-state LCD display. Additionally, the network display shall include ten soft-keys for screen navigation and the ability to scroll events by type. i.e. Fire Alarm, Supervisory Alarm, Trouble, etc.

The network control annunciator shall have the ability to display up to eight events in order of priority and time of occurrence. Counters shall be provided to indicate the total number of events by type.

The RP shall mount in any of the network node fire alarm control panels. Optionally, the network display may mount in a backbox designed for this use. The network shall support a minimum of 103 network control annunciators (not to exceed total node capacity) and shall connect to the network over either a wire or fiber interface.
The network control annunciator shall have an event history buffer capable of storing a minimum of 1000 events in non-volatile memory. Additionally, the RP shall have a fire alarm history buffer capable of storing a minimum of 200 events in non-volatile memory. Systems that do not protect fire alarm events from being overwritten by other events are not suitable substitutes.

The RP shall include two optically isolated, 9600 baud, industry standard EIA-232 ports for UL864 listed printers and CRT's. These peripheral devices shall print or display network activity.

The network control annunciator shall include control switches for system wide control of Acknowledge, Signal Silence, System Reset, Drill, and local Lamp Test. A mechanical means by which the controls switches are "locked out", such as a key, shall be available.

The RP shall include long life LEDs to display Power, Fire Alarm, Pre-Alarm, Security Alarm, System Trouble, Supervisory, Signals Silenced, Disabled Points, Other (non-fire) Events, and CPU Failure.

The network control annunciator shall include a Master password and up to nine User passwords. Each password shall be up to eight alpha-numeric characters in length. The Master password shall be authorized to access the programming and alter status menus. Each User password may have different levels of authorization assigned by the Master password.

The RP shall allow editing of labels for all points within the network; control on/off of outputs; enable/disable of all network points; alter detector sensitivity; clear detector verification counters for any analog addressable detector within the network; clear any history log within the network; change the Time/Date settings; initiate a Walk Test.

The network control annunciator shall support an optional WindowsTM based program utility. This utility shall allow the user create an RP database, upload/download an RP database, and download an upgrade to the RP executive. To ensure program validity, this utility shall check stored databases for errors. A compare function shall be included to identify differences between databases.

For time keeping purposes the RP shall include a time-of-day clock.

Each RP shall support up to 32 additional 80-character remote display annunciators for displaying network activity. These "Terminal Mode" displays will mimic the activity appearing on the corresponding RP.

Speakers:
All speakers shall operate on 70 VRMS or with field selectable output taps from 0.25 to 2.0 Watts.

Speakers in corridors and public spaces shall produce a nominal sound output of 84 dBA at 10 feet (3m).

Frequency response shall be a minimum of 400 HZ to 4000 HZ.
The back of each speaker shall be sealed to protect the speaker cone from damage and dust.

Graphic User Interface (GUI)
The GUI shall utilize a Microsoft(tm) operating system. Each Network Control Station shall be capable of graphically annunciating and controlling all network activity. Network display devices that are only capable of displaying a subset of network points shall not be suitable substitutes.
The GUI shall be an IBM (or compatible) personal computer with the following minimum requirements: Intel Pentium II(tm)-processor, operating at a minimum of 400 Mhz, 128Mbytes of RAM, 8 Mbytes Video RAM, 1.44 Mbyte floppy drive, 3.2 Gbyte hard disk, mouse, 32X CD-ROM, 3PCI / 1 ISA expansion slots, internal 3.2 Gbyte tape drive, sound card, 200-watt power supply, and SVGA graphics with a screen resolution of 1024 x 768. The network control station shall include a 19-inch monitor.

The GUI shall be capable of storing over 100,000 network events in a history file. Events shall be stored on hard disk and shall be capable of back-up storage to a tape drive. The history buffer allows the operator to view events in a chronological order. A filter shall be available for displaying chronological events by operator, date, time, fire alarms, troubles (including security, supervisory and system/device), disabled points/zones, system programming, operator response and operator log in/log out. The ability to print GUI history files shall also be available.

The GUI shall use a Windows(tm) dialog box technology to address, interrogate, control, and/or modify intelligent points on each fire alarm node. This shall include, and not be limited to: Activating outputs, enabling or disabling points, adding or removing intelligent points, viewing intelligent detector sensitivity levels and modifying point information (custom messages, detector type, verification, day/night selection etc.)

The GUI shall include the ability to display system information in a graphical (floor plan) form. Each view, created using standard Windows bitmap files, shall include icons created for intelligent devices. These icons shall blink and change to the appropriate programmed icon when an event occurs. When the device has been acknowledged, the icon shall become steady. Once the point has returned to normal, the normal icon is displayed. In addition to the graphical representation of the device, the user shall be able to link pictures, documents and sound files to the device. The GUI shall also provide the ability to auto-vector to the floor plan (screen) of the device that is active. By selecting a device in the graphic presentation, the operator of the GUI shall have the ability to log onto the corresponding node and interrogate the associated intelligent point.

The GUI shall have the ability to provide the following information through a Windows(tm) pull down menu: An Event Counter that contains the number of new and total events on the network. The information that is displayed shall consist of Fire Alarms, Pre-Alarms, Security Alarms, Supervisory Alarms, and Troubles. Detailed Event windows that contain all Off-Normal events, both unacknowledged and acknowledged that are present in the system. It shall contain two views, Fire events and Non-fire events that shall be user selectable. A Current Event window that shall contain all network and local events as well as system messages with a maximum of 1,000 events displayed. A Disabled Device window that shall contain all disabled devices in the system.

The GUI shall have the option, from a Windows pull down menu, to connect to a third-party paging service that allows the GUI to automatically send text-based messages regarding system status to a typical text pager.

The GUI shall include help screens, available to aid the user without leaving the selected application screen.
The GUI shall be UL-Listed for fire protection (UL864) and burglary (UL1076).

The GUI shall meet FCC regulations (Part 15, subpart J) regardless of its connection means to the network.

The GUI shall have a flexible way of assigning operator passwords. There shall be an unlimited number of possible operators, each with specific levels of control. Each operator shall have his/her own password. Operator password and control selection shall be available to a high level "administrator" who shall have complete control over levels of control. If no action has taken place on the GUI after 10 minutes, the current operator shall be logged out and require a new log-in.

The GUI shall include an industry-standard EIA-232 port for a UL864 listed printer.

The GUI shall be a table top hardware configuration.

Video Display Terminal

The Video Display Terminal shall provide a visual display and an audible alert of all changes in status of the system and shall annotate such displays with the current time-of-day and date.

The Video Display Terminal shall be enclosed in a cabinet suitable for placement on a desktop or table.

A detachable keyboard shall be provided that may be used for programming, testing, and control of the system. Individual keys shall be provided on the keyboard for the ACKNOWLEDGE, RESET, LAMP TEST, SYSTEM TEST, and SIGNAL SILENCE functions of the control panel.

The video display terminal shall include a count of all alarms and troubles in the system, as well as a count of all alarms and trouble requiring acknowledgment. These counts shall be continuously displayed during all FACP operations.

SYSTEM COMPONENTS - ADDRESSABLE DEVICES

Addressable Devices - General

Addressable devices shall use simple to install and maintain decade, decimal address switches / software adjustable. Devices shall be capable of being set to an address in a range of 001 to 159/125. Alternatively, the loop controller shall electronically address each detector, saving valuable time during system commissioning. Each detector shall have its own unique serial number stored in its "on-board memory". The loop controller shall identify each device on the circuit and assigns a "soft" address to that device's serial number.

Addressable devices, which use a binary-coded address setting method, such as a DIP-switch, are not an allowable substitute.

Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the fire alarm control panel Signaling Line Circuits.

Addressable smoke and thermal detectors multicriteria shall provide dual alarm and power/polling LEDs. Both LEDs shall flash green under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both single LEDs shall be placed into steady / flash red illumination by the control panel, indicating that an alarm condition has been detected, red & green LED shall glow steady if the detector senses fine in the stand-alone mode. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED. Alternatively, the detector shall have Twin LEDs which shall be visible from any direction. A flashing GREEN LED shows normal system polling from the loop controller. A flashing RED LED means the detector is in alarm state. Both LEDs on steady shows alarm state - stand-alone mode.

Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7. The panel on a time-of-day basis shall automatically adjust sensitivity.

The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Bases shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications.

The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.

Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device.

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

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

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

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

Addressable Manual Fire Alarm Box (manual station)

Addressable manual fire alarm boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.

All operated stations shall have a positive, visual indication of operation and utilize a key type reset.

Manual fire alarm boxes shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.

Smoke Detector - Multi-Sensor Photo Thermal

Provide analog/addressable multisensor smoke detectors at the locations shown on the drawings. Alarm condition shall be based upon the combined input from the photoelectric and thermal detection elements. Separately mounted photoelectric detectors and heat detectors in the same location, clustered at the manufacturer's listed spacing is an acceptable alternative. The detector shall have the ability to set the sensitivity and alarm verification of each individual detector on the circuit. It shall be possible to automatically set the sensitivity of individual analog/addressable detectors for the day and night periods.

Each smoke detector shall be capable of transmitting prealarm and alarm signals in addition to the normal, trouble and need cleaning information. It shall be possible to program control panel activity to each level. Each smoke detector may be individually programmed to operate at any one of five (5) sensitivity settings. Each detector microprocessor shall contain an environmental compensation algorithm that identifies and sets ambient environmental thresholds approximately six times an

hour. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 75% and 100% of the allowable environmental compensation value.

Intelligent Thermal Detectors

Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.

Intelligent Multi-Criteria Sensing type Photoelectric Smoke Detector
The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall be in position to work in advance multi-Criteria Sensing, on command from the control panel, send data to the panel representing the analog level of smoke density.

Intelligent Duct Smoke Detector

1. The smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, of that provides continuous analog monitoring and alarm verification from the panel.

2. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

Addressable Control Module

1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances.
2. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation.
3. Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised UL listed remote power supply.
4. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.

Addressable Relay Module
1. Addressable Relay Modules shall be available for HVAC control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to ensure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

Isolator Module
1. Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment

or branch. At least one isolator module shall be provided for each floor or protected zone of the building.

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

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

4. The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

Fire Fighter Telephone

Firefighters' telephones shall be typically installed in corridors, lobbies, mechanical rooms, stairways, or other strategic locations. When lifted from its cradle, or plugged into a suitable wall jack, the handset shall activate audible and visible signals at the control panel. There, the operator needs only to lift the handset off the cradle to respond to the current call. Other firefighters' telephones may be selected at the control panel to join the conversation.

BATTERIES:

The battery shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 5 minutes of alarm upon a normal AC power failure.

The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.

If necessary to meet standby requirements, external battery and charger systems may be used.

EXECUTION

INSTALLATION:

Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

Manual fire alarm boxes shall be suitable for surface mounting or semi-flush mounting as shown on the plans, and shall be installed not less than 42 inches (1067 mm), nor more than 48 inches (122 mm) above the finished floor.

TEST:
The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72, Chapter 7.

Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.

Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.

Verify activation of all waterflow switches.

Open initiating device circuits and verify that the trouble signal actuates.

Open and short signaling line circuits and verify that the trouble signal actuates.
Open and short notification appliance circuits and verify that trouble signal actuates.

Ground all circuits and verify response of trouble signals.

Check presence and audibility of tone at all alarm notification devices.

Check installation, supervision, and operation of all intelligent smoke detectors using the walk test.

Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.

When the system is equipped with optional features, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

FINAL INSPECTION:
At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

INSTRUCTION:
Instruction shall be provided as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.

The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

SUBHEAD: Q: <u>CCTV SYSTEM</u>

A. The CCTV equipment shall have UL & CE Certifications.

1. Black& White Fixed CCTV Camera
   The Camera shall operate on 12V DC
   The Camera shall have a 1/3" CCD
   The Camera shall work in minimum 0.5 lux illumination
   The Camera shall have a fixed 3.6mm lens for C- mount indoor cameras.

2. Color C/CS Mount Weather Proof camera.

a. The camera shall be 1/3" CCD, 480HTV and 0.3 Lux.

b. The camera shall have the 5mm to 50mm at F 1.8 Varifocal auto Iris lens in 1/3" format.

c. The camera shall have the competence of Video/DC selectable, Sharpness selectable and ATW / AWB.

d. Cameras shall be mounted in imported aluminum weather proof housings of approved finish for the outdoor applications along with suitable mounting brackets.

e. It should be suitable to operate both in day / night mode with low lux sensitivity. Day mode shall be 2-lux and Night mode shall be 0.016 lux.

3. Color Dome fixed lens Cameras.

a. The camera shall be 1/3" CCD,410 K pixels, 480 HTV and 0.3 Lux.

b. The camera shall have the competence of Video/DC selectable, Sharpness selectable and ATW / AWB.

c. The Camera shall operate on 12V DC.

d. The Camera shall have a fixed 3.6mm lens for C- mount indoor cameras.

4. SVGA Monitor

a. The Monitor shall operate on 230V AC.

b. The Monitor shall have a minimum resolution of 1024*768.

c. The Monitor shall have controls for brightness, contrast etc. at the front of the cabinet.

d. The Monitor shall have a screen size of 17 inches.

5. Digital Video Recorder

a. The DVR shall be UL listed& operate on 230V AC.

b. The DVR shall be capable of recording up to 360 hours & back-up facility also.

c. The DVR shall have Multiplexed view (16 Cameras) Possible.

d. It shall be possible to Control and record the data from all the cameras in real time mode and providing interface to the LAN over TCP/ IP.

e. It shall be possible to view the recording on event basis or intelligent basis, the system shall support multi area motion detection.

f. The software of DVR shall be capable of programming reason of interest for recording.

g. Total 240 FPS for all 16 Cameras (480fps full live video) with provision for adjusting the recording rate from 0 to 25 FPS for each camera channel.

h. The system will combine the function of a multiplexer, VCR, and telemetry switcher for system versatility and functional use with large system. It shall offer full triplex operation.

i. It will have capability of VMD and activity detection.

j. It will have telemetry control for PTZ cameras.

k. Rack mounted option shall be provided.

TECHNICAL SPECIFICATIONS

SUB-HEAD: A. SUPPLY OF D. G. SETS

1.0 GENERAL SPECIFICATIONS

a.	Actual Capacity after de-rating for site conditions	:	**1010 KVA and 500 kVA**, 415 Volts, 3 phase, 4 – wire 50 Hz. Pure sine wave, 1500 RPM, prime duty base load application
b.	Ambient conditions	:	Minimum temperature: 4°C during winter Maximum temperature: 45°C during summer Relative Humidity: 20% to 90%
c.	Duty cycle	:	Continuous 24 hours, 7 days a week, with 10% over-loading for one hour in every 8 hours.
d.	Starting	:	The sets shall be suitable for Auto start-up with provision for manual start and stop.
e.	Standards	:	The system will have to be in accordance with relevant BSS/ ISS/ DIN or any other internationally accepted standard.
f.	Fuel	:	The diesel generating sets shall be capable of working on Ultra Low Sulfur Diesel (ULSD).
g.	Scope of Supply	:	Diesel Engine: The set should be complete with a diesel engine of suitable BHP rating to give the desired alternator output of 1010 and 500 **KVA** (taking into account de-rating factors for the ambient conditions specified). **Radiator fan mounted on the engine.** Alternator: Alternator is to generate **1500 and 500 KVA**, of output power at 415 Volts, 50 Hz, pure sine-wave form (with brushless excitation system and built in AVR) mounted on a common base-plate with suitable coupling to the diesel engine and foundation bolts with suitable termination box for connection to a control panel. Alternator capacities shall be suitable for the ambient conditions considering necessary de-rating factors. Starting System: Starting by Electrical Motor, suitable voltage and capacity (preferably 24 V DC) and the supply should be from a set of batteries. The charging circuit for the battery should be built in the L.T. Panel with current controlling type with provision for trickle & boost charge. Engine will also have inbuilt charger alternator.

Fuel Supply: Day tank for each of the sets shall be included in the scope of supply.

h. DOCUMENTATION : Two sets of complete detailed documentation is to be provided for installation, commissioning and maintenance of the engine, alternator, control panel and other sub-systems, comprising of general and dimensional layout drawings, foundation details, wiring and schematic drawing, inter-piping and inter-cabling drawings, installation instructions, operation, maintenance and service manuals, part list, spare-parts catalogue, third party supplied catalogue, are to be supplied along with the main equipment.

Test Certificates: All test certificates at works with regard to diesel engine, turbo-charger fuel pump, governor, fuel injection system, silencer, alternator, AVR, excitation system and control panel shall be supplied in six copies.

2.0 DETAILED SPECIFICATIONS

2.1 GENERAL:

DG Sets, coupled to a suitable alternator to give a continuous output of **1010 and 500 KVA** at 415 Volts, 1500 RPM, 3-Phase, 4-Wire, 50Hz, Pure-Sine wave form. The rating of **1010 and 500 KVA** is required at site conditions of 45^{o}C ambient and should be arrived at after taking into consideration all de-ration factors.

3.0 DIESEL ENGINE

3.1 Turbo-charged, Vertical/V cylinders, Diesel engine with cylinders either in line or in V formation, counter-clockwise rotation, Water-cooled with **Radiator type of Cooling** with turbo charger, charge air cooled-Direct injection – Four stroke, compression ignition- D.C. motor starting – Designed for operation with fuel oil and lube oil as per enclosed specifications – Continuous rated output of **1010 and 500 KVA** at 1500 RPM – Stationery type conforming to IS/ BS/ DIN or any other equivalent internationally accepted standards.

3.2 Output: **1010 and 500 KVA**, at site at ambient temperature of 45^{0}C. (This is the rating required at site after taking into consideration all de-ration factors).

3.3 Standard accessories for the Engine:

a. Exhaust driven turbo charger with insulated piping.

b. Day tank: Outdoor mounting type with capacity to hold fuel oil required for running the diesel engine on full load for 8 hours, flow pipe, drain pipe, fuel oil level indicator, man-hole for inspection, etc. (all pipes connected through flanged joints).

c. Lubrication System: Sump tank incorporated in the common base frame for Diesel engine and generator, with one level switch for minimum level alarm – with shell type oil to air heat

exchanger (with flanged pipe connection) coarse and fine filters with by-pass arrangements in the lubricating circuit when the engine is on and with automatic by-pass valve for the filter in case of filter getting clogged. Thermostatic by-pass valve for lube-oil heat exchanger when the lube oil is cold, lube oil pressure gauge, lube oil temperature indicating devices, both at the inlet and outlet of the lube-oil heat exchanger.

d. Speed Load Regulation:

Controller

The speed governing system should be compatible to parallel operation with other DG Sets and utility mains, for selective load sharing in manual/ auto conditions.

e. Fuel Oil: Engine shall be equipped with fuel oil filters-fine and coarse. The fuel consumption of the engine shall be expressed by the Contractor in the bid in liters per gross/net kWh output from the alternator (after supplying the requirements of auxiliaries) at full, three quarters and half of its rated power output and at 0.8 and unitary power factor. A fuel service tank of suitable capacity with each D.G. Set shall be provided on a suitably fabricated steel platform. The tank shall be complete with level indicator marked in liters, filling inlet with removable screen, an outlet, a drain plug, an air vent and necessary piping. The fuel tank shall be painted with oil resistant paint. All pipe joints should be brazed/ welded.

f. Engine Cooling System: The diesel engine shall be provided with radiator fans for radiator type of DG set & Heat exchanger connected with cooling tower through pump & piping for Heat exchanger type DG sets.

g. Charge AIR system: Charge air for the engine shall be through a turbo charger with flexible expansion joint, transition pipe with an intermediate air cooler – Dry type filter, dry type air cleaner and absorption silencers at the air inlet point.

h. Exhaust system: Exhaust from the engine manifold shall be connected to the turbo charger through a flexible expansion joint or SS flexible connection. Outlet from the turbo charger should be connected to the exhaust silencers (residential type) through another set of expansion joint-preferably of Bellows type and the entire exhaust piping shall be fully insulated by means of flagging and cladding. Provision shall be available for tapping exhaust gas after turbo charger for analysis purpose.

i. Water In/Out temperature monitoring at heat exchanger inlet and outlet.

j. Fuel oil level indicator for the day tank.

k. The sets shall be provided with vibration isolation pads, the main frame and the accessories as well as flexible vibration insulation joints for all piping.

l. ALTERNATORS:

Self-regulating, three-phase synchronous alternator, Brushless TEFC with copper windings, antifriction bearing, flanged shaft, suitable for parallel operation and synchronizing with each other and mains supply, damper cage for parallel operation, fully tropicalized insulation (class H) temperature sensors located in the windings, over-riding controls for manual operation of excitation system, all the six terminals brought out, suitable for delivering the full load at 45^{o}C

conforming to relevant ISS/ BSS/ DIN any other internationally accepted standard or equivalent.

Output: **1010 and 500 KVA** 0.8 pf lagging

Voltage: 415 Volts, 4- wire, 3 phase, solidly earthed neutral power system. The steady state voltage stability shall be ± (0.5%) from no load to full load, and at power factors from 0.7 to 1.0 and for any speed variation unrelated to load of approximately 1%.

Wave Form	:	Pure sine wave, free of all harmonics.
Frequency	:	50 Hz
Speed	:	1500 rpm
Protected against	:	Over-load, short circuits, earth faults, winding protection, differential type winding over-temperature. Transient surges and lightning protection. Earth leakage protection as specified by Elec. Inspectorate
Earthing facility	:	Earth lugs on the alternator should be provided for two separate earth connections.
Over-load	:	10 % for one hour in every eight hours.
Exciter	:	Brush less revolving-field, built-in AC exciter with Rotating rectifiers, automatic regulation with suitable accessories, and provision for adjusting the terminal voltage by means of a continuous trimmer by ± 5% of the nominal Voltage.

m. Starter Battery:

Starting battery each of 12 V, heavy duty high performance approved make/quality shall be provided to enable crank & start the engine even in cold/winter morning conditions. Type/voltage/AH capacity of same on 20 hour rated discharge period shall be indicated in the offer. The battery set shall be capable of performing at least (5) five normal starts without recharging.

The battery shall be provided with good quality iron battery stand painted with acid proof black paint with min 3mm thick rubber mat below the battery.

Batteries shall be of load container type only and not with PVC moulded sealed container so that each individual cells are available for individual monitoring during its life span. Each cell shall be provided with electrolyte filling cap with level floats for easy monitoring of electrolytic level.

The battery shall be provided with 2 Nos. cables, minimum 1.5m long heavy-duty rubber/PVC insulated cabling with brazed tinned lug at one end and with brazed tinned brass terminal lug at battery end - for connecting batteries to cranking system - with 0.25 m long inter battery connecting cable.

The lugs shall be clearly stamped (+) or (-) and positive cable also red sleeved for easy identification.

The batteries Set shall be supplied fully filled and first charged ready to use.

Batteries set shall be supplied with spring type hydrometer, thermometer with specific gravity correction scale and cell testing voltmeter etc.

n. CONTROLLER

DG Set shall be complete with its controller. This controller shall be capable of enabling auto start / stop of DG Sets & auto synchronization of DG Sets. Various features of controllers offering safeties, protection and metering shall be as per the details mentioned in the BOQ.

o. ACOUSTIC ENCLOSURE/ HOOD
DG Set with acoustic enclosure shall be:

The enclosure is fabricated out of CRCA sheet of 14 SWG

The sheet metal components are hot dipped in NINE TANKS pretreated before powder coating.

Enclosure is powder coated (inside as well outside) with a special pure polyester-based powder. All Nuts and, bolt/external hardware are made from stainless steel.

The doors are gasketed with high quality EPDM gaskets to avoid leakage of sound.

The door handles are lockable type.

Sound proofing of enclosure is done with high quality rock wool/mineral wool.

The rock wool is further covered with fiber glass cloth and perforated powder coated MS sheet.

Specially designed attenuators are provided to control sound at air entry to the container and exit from the container.

Adequate ventilation is provided to meet air requirement for combustion and heat removal.

Temperature of enclosure does not exceed beyond 5-7°C of ambient temp.

There should be a provision for emergency shutdown from outside the enclosure.

Noise levels shall be as per CPCB norms with acoustic enclosure.

Door hinges are made of anti-corrosive special alloy.

q. NOISE LIMIT FOR GENERATOR SETS RUN WITH DIESEL:

1. Noise limit for diesel generator sets (up to 1010 KVA)

The maximum permissible sound pressure level for new diesel generator (DG) sets with rated capacity up to 1010 KVA, manufactured on or after the 1st July, 2003 shall be 75 dB(A) at 1 meter from the enclosure surface.

The diesel generator sets should be provided with integral acoustic enclosure at the manufacturing stage itself.

2. Noise limit for DG sets not covered by above paragraph 1 (above 1010 KVA)

Noise limits for diesel generator sets not covered by paragraph 1, shall be as follows:

i. Noise from DG set shall be controlled by providing an acoustic enclosure or by treating the room acoustically, at the users end.

ii. The acoustic enclosure or acoustic treatment of the room shall be designed for minimum 25 dB (A) insertion loss or for meeting the ambient noise standards, whichever is on the higher side (if the actual ambient noise is on the higher side, it may not be possible to check the performance of the acoustic enclosure/acoustic treatment. Under such circumstances the performance may be checked for noise reduction up to actual ambient noise level, preferably, in the night time). The measurement for Insertion Loss may be done at different points at 0.5 m from the acoustic enclosure/room, and then averaged.

iii. The DG set shall be provided with proper exhaust muffler with insertion loss of minimum 25 dB(A).

iv. These limits shall be regulated by the State Pollution Control Boards and the State Pollution Control Committees.

v. Guidelines for the manufacturers of Diesel Generator sets shall be as under:

- The manufacturer shall offer to the user a standard acoustic enclosure of 25 dB(A) insertion loss and also a suitable exhaust muffler with insertion loss of 25 dB(A).

3. EMISSION LIMITS FOR NEW DIESEL ENGINES (UP TO 800 KW) FOR GENERATOR SETS (GENSETS) APPLICATIONS:

The emission limits for new diesel engines up to 800 kW, for Gensets applications shall be as given in the Table below:

Table:

Capacity of diesel engines	Date of implementation	Emission Limits (g/kw-hr) for				Smoke Limit (light absorption coefficient, m^{-1})(at full load)	Test cycle	
		NOx	HC	CO	PM		Torque %	Weighting factors
Upto 19 kw	1.7.2003	9.2	1.3	5.0	0.6	0.7	100	0.05
	1.7.2004	9.2	1.3	3.5	0.3	0.7	75	0.25
>19 kw upto 50 kw	1.7.2003	9.2	1.3	5.0	0.5	0.7	50	0.30
	1.7.2004	9.2	1.3	3.5	0.3	0.7	25	0.30
>50 kw upto 260 kw	1.7.2003	9.2	1.3	3.5	0.3	0.7	10	0.10
> 260 kw upto 800 kw	1.7.2004	9.2	1.3	3.5	0.3.	0.7		

SUB-HEAD: B. INSTALLATION OF D. G. SETS

1.0 GENERAL:

1.1 The preliminary drawings shall be provided by the **CLIENT** to the contractor and based on these drawings contractor shall prepared and submit detailed and working drawing to **CLIENT.** After getting the approval by **CLIENT** duly signed and stamped, the work shall be carried out in the accordance with the approved drawings and design. The contractor shall not take cognizance of any drawings, designs, specifications etc. not bearing **CLIENT** representative's signature and stamp. Similarly, the contactor shall not take cognizance of instructions given by any other authority except the instructions given by the Engineer-in-charge in writing.

1.2 The work shall be executed and measured as per metric dimensions given in the Schedule of Quantities/ drawings etc.

1.3 The Contractor shall acquaint himself fully with the partial provisions for supports that may be available in the structure and utilize them to the extent possible. In any case the contractor shall provide all the supports regardless of provisions that they have been already made. Nothing extra shall be payable for situations where insert plates (for supports) are not available or are not useful.

1.4 MEASUREMENTS

All measurements shall be taken in accordance with relevant BSI/ NBS codes unless otherwise specified.

2.0 APPLICABLE CODES, STANDARDS AND PUBLICATIONS

All equipments supply, erection, testing and commissioning shall comply with the requirements of International Standards and code of practice given below as amended to date. All equipments and material being supplied by the Contractor shall meet the requirements of standards, Tariff advisory committee's regulation (fire insurance). Local Authorities, electrical inspectorate, pollution emission norms as may be prescribed by the competent authority and other Codes/ publications including NEMA, TEMA.

3.0 QUALITY ASSURANCE AND QUALITY CONTROL

3.1 The works shall conform to high standard of design and workmanship, shall be structurally sound and aesthetically pleasing. Quality standards prescribed shall form the backbone for the quality assurance and quality control system.

3.2 At the site, the Contractor shall arrange the materials and their stacking/storage in appropriate manner to ensure the quality. Contractor shall provide equipment and manpower to test continuously the quality of material, assemblies etc. as directed by the CLIENT. The test shall be conducted continuously and the result of tests maintained. In addition the Contractor shall keep appropriate tools and equipment for checking alignments, levels, slopes and evenness of surface.

3.3 The **CLIENT** shall be free to carry out such tests as may be decided by him at this sole discretion, from time to time, in addition to those specified in this Document. The Contractor

shall provide the samples and labor for collecting the samples. Nothing extra shall be payable to the Contractor for samples or for the collection of the samples.

3.4 Prior to shipment, complete unit shall be tested under actual load conditions for performance and proper functioning of component parts.

4.0 DC BATTERY SYSTEM:

4.1 The batteries shall be installed duly acid filled uncharged with stand. At time of testing & commissioning of DG sets battery shall be charged by the contractor.

5.0 PIPING:

5.1 Water Piping:

Water pipes and all fittings shall be M.S. Class 'C' (Heavy Class) conforming to relevant BIS Codes. All jointing in the pipe system shall generally be by welding, unless otherwise mentioned, or directed at site. All welding shall be done by qualified welders and shall strictly conform to BIS Code of practice for manual metal arc, welding of Mild Steel.

All pipes and their steel supports shall be thoroughly cleaned and given one primary coat of red oxide paint before being installed. All welded piping shall be subject to the approval at site.

Fittings shall be malleable casting of pressure rating suitable for the piping system. Fittings used on welded piping shall be of the weldable type.

Tee-off connections shall be through equal or reducing tees, otherwise ferrules welded to the main pipe shall be used. Drilling and tapping of the walls of the main pipe shall not be resorted to.

Gate, Globe and butterfly valves conforming to the following specifications shall be provided as shown on Drawings :

Size	Construction	Ends	Type
15 to 25 mm	Gun Metal	Screwed	Gate/Globe
30 mm	Gun Metal	Flanged	Gate/Globe
40mm and over	Body cast iron, nitrile rubber seat	Flanged	Butterfly

Valves shall be suitable for not less than 10 Kg per Sq. cm. Gauge working pressure.

Butterfly valves shall perform the function of isolating valves. Butterfly valves shall have cast iron body with black nitrile rubber seat. All butterfly valves shall be provided with locking devices.

Flanges: The supply of flanges shall also include supply of bolts, washers, nuts and suitable asbestos fiber/rubber insertion gaskets (minimum 3mm thick).

Non return valves shall be dual plate check valve provided as shown on the Drawings, conforming to relevant Codes and in accordance with the following Specifications:

Size	Construction	Ends
50 to 150 mm	Body cast iron, gun metal plate.	Flanged
200 mm to 450mm Overlay.	Body Cast iron, plate carbon Flanged	Steel with 13% chrome

The spring and hinge / stop pin shall be SS304 and bearing PTFE material. Valves shall be suitable for not less than 10 Kg per sq.cm gauge working pressure.

Strainers shall be 'Y' type as shown on the Drawings, with cast / MS bodies designed for the test pressure specified for the valves. Strainers shall have bronze/brass screen with 3 mm perforations. Screen shall be removable and replaceable without disconnection of the main pipes. All strainers shall be provided with equal size isolating butterfly valves so that the strainer may be cleaned without draining the system.

All water piping and fittings shall be pressure tested.

5.2 Piping Installation:

The Contractor, on award of the work, shall prepare detailed shop drawings, showing the cross-section, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air valves, and all pipe supports. He must keep in view the specific openings in buildings and other structures through which pipes are designed to pass.

Piping shall be properly supported on, or suspended from, stands, clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers and be responsible for their structural sufficiency. Approval shall be taken for the same before installation.

Pipe supports shall be of steel, adjustable for height and primer coated with rust preventive paint and two coats of finish black paint. Where pipe and clamps are of dissimilar materials a gasket shall be provided in between.

Spacing of pipe supports shall not exceed the following:

Pipe Size (mm)	Spacing (M)
3 to 12	1.2
19 to 25	1.8
32 to 150	2.4
150 and above	3.0

Pipe hangers shall be fixed on walls, beams and ceilings by means of metallic rawl plugs.

Auto air vents shall be provided at all high points in the piping system of venting. Air valves shall be 15mm pipe size valves with several joints. Discharge from the air valves shall be piped through an equal sized mild steel or GI pipe to the nearest drain.

Painting: All pipes shall be given two coats of primer and two coats of finish paint of approved shade.

5.3 Testing:

All piping shall be tested to hydrostatic test pressure of at least two and half times the maximum operating pressure, but not less than 10 kg per sq.cm gauge for a period of not less than 36 hours. All leaks and defects in joints revealed during the testing shall be rectified and gotten approved at site.

Piping repaired subsequent to the above pressure test shall be re-tested in the same manner.

System may be tested in sections and such sections shall be securely capped, then re-tested for entire system.

The Contractor shall give sufficient notice to all other agencies at site of his intention to test a section or sections of piping and all testing shall be witnessed and recorded by Owner's site representative.

The Contractor shall make sure that proper noiseless circulation of fluid is achieved through heat exchanger equipment in the system concerned. If connection, the Contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications including the tearing up and re-finishing of floors and walls as required.

The Contractor shall provide all materials, tools, equipment, instruments, services and labor required to perform the test and to remove water resulting from cleaning and after testing.

6.0 EXHAUST PIPING.

6.1 The exhaust piping system shall be of heavy duty of MS pipes thickness as mentioned in the BOQ. Suitable length of flexible piping shall be used for connecting the piping to the engine as per the recommendations of manufacturers.

All terminal connections and pipe joints shall be of welded construction. The terminals of sizes 2 inches & above shall be butt welded.

The welding shall be done as per relevant ASME/ ASA codes. The contractor will have to indicate beforehand the welding procedure proposes to use. After confirmation by the **CLIENT,** the procedure which is finalized shall be strictly adhered to.

All pipes shall be supported with necessary supporting arrangement and approval shall be taken for the same before execution.

7.0 INSULATION WORKS OF DG EXHAUST PIPE.

7.1 GENERAL

The Insulation of exhaust pipe shall be carried out as per specifications given below & as specified in bill of quantities (BOQ):

7.2 MATERIALS

The materials to be used for insulation shall be as follows, unless some other material is specifically mentioned elsewhere. The detailed specifications of the materials are listed under respective sub head. **Refer BOQ for the exact insulation type and thicknesses. Details given below are for various options of insulation.**

OPTION – 1

Pipe insulation	:	Rock wool
Surface Temperature	:	Up to 450 °C
Density	:	150 Kg/m^3
Thickness of insulation	:	75mm
Cladding	:	26G Aluminum

OPTION – 2

a. First Layer

Pipe insulation	:	Ceramic Fibre wool
Surface Temperature	:	Up to 450 °C -1260°C
Density	:	128 Kg/m^3
Thickness	:	25mm

b. Second Layer

Pipe insulation	:	Rock wool
Surface Temperature	:	Up to 450 °C -1260°C
Density	:	150 Kg/m^3
Thickness	:	100mm
Cladding	:	26G Aluminum

Scope:

The scope of this section comprises the supply and application of insulation conforming to these specifications & as mentioned in the BOQ.

7.3 PIPE INSULATION: - UNEXPOSED & EXPOSED TO WEATHER.

a) Clean the surface of the pipe with wire brushes manually.

b) Check the size and length of pipe to be insulated and cut the pre-formed Ceramic wool/ Rockwool.

c) Providing and applying a layer of MAS-17 adhesive over pipe length.

d) Fix the 25 mm thick Ceramic wool pre-formed pipe section – 128Kg/ m^3 density followed by another layer of 100mm Rockwool of 150 Kg/ m^3 density.

e) Cover the insulated pipe with 26 SWG aluminum sheet with proper overlaps at circumference with the self-tapping screws fixed at maximum 150 mm distance all throughout the overlapping.

f) After completion of work, remove burrs, dirt, and construction debris, and repair any damaged finishes including chips, scratches, and abrasion. The work location is clean and tidy.

7.4 MEASUREMENT OF INSULATION: Unless otherwise specified measurement for insulation for the project shall be on the basis of center line measurement.

7.5 MEASUREMENT OF PIPING

a. Unless specified otherwise, measurement for piping for the project shall be on the basis of center line measurements described herewith.

b. Piping shall be measured in units of length along the center line of installed pipes including all pipe fittings, flanges (with gaskets, nut, bolts for jointing), unions, bends, elbows, tees, concentric and/ or eccentric reducers, inspection pieces, expansion loops etc. The above accessories shall be measured as part of piping length along the center line of installed pipes and no special multiples of pipe lengths for accessories shall permitted.

c. The quoted rates for center line linear measurements of piping shall include all wastage allowances, pipe supports including hangers, MS channel, wooden haunches, nuts, check nuts, vibration isolator suspension where specified of required and any other item required to complete the piping installation as per the specifications. None of these items will be separately measured nor paid for.

d. However, all valves (gate/ globe/ check/ purge/ butterfly/ drain etc.). Strainers, thermometers, pressure gages shall be separately counted and paid as per BOQ include.

8. INSPECTION AND TESTING AT SITE

8.1 All pre-commissioning and commissioning test and checks shall be carried out at site. The contractor shall be required to produce manufacturer's test certificate for the particular batch of materials supplied to him by the manufacturers. The test carried out shall be as per the relevant standards.

8.2 For examination and testing of materials and the works at site the Contractor shall provide necessary testing and gauging equipment as required. All such testing and gauging equipment shall be tested for calibration at any approved labor at any required by the **CLIENT.**

8.3 The Contractor shall give notice well in advance to the **CLIENT** before commencement of any site testing. All materials like consumable stores, fuel oil grease, lubricating oil etc. required for the trails shall be arranged by the contractor.

8.4 The Contractor shall make all necessary hook-ups to carry out tests at site and shall furnish necessary fuel.

8.5 The complete installation should be initially started and checked out for operational compliance by manufacturer's representative.

9.0 TRIALS (AT SITE) FACTORY TRAILS FOR 3 PERSONS

9.1 PRIMARY TRIALS

After completion of erection of generating sets and before carrying out main trials, preliminary site trials shall be conducted in the presence of **CLIENT** representative. Such trial shall include the checking and adjustment of all the instrument relays. Timers, interlocks and

meters. Insulation resistance of stator, rotor and exciter windings shall be checked and reading recorded and their starting accessories supplied with the set.

9.2 MAIN TRIALS

a. The main trials shall include over 8 hours continuous run at full load.

b. Alternator efficiencies as determined in works test shall be used as the basis of calculation for fuel consumption rate. A tolerance of 3% shall be allowed on the fuel oil consumption to cover possible errors in measurement. Tests providing the satisfactory performance of all safety and operating controls shall be carried out. Governor trials shall be carried out as laid down in BS: 5514. Alternator insulation resistance & commutation check shall be as per BS: 5000.

c. Starting time of sets shall be tested at least five times after sufficient time intervals to allow for cold start. On completion of test, inspection doors shall be removed and running gears inspected and alignment checked. Any further reasonable trial as suggested by the **CLIENT** shall be carried out with no extra charges. All instruments, materials and labor required for carrying out the trials shall be provided by the Contractor. Test sheet of trials shall be forwarded in quadruplicate to **CLIENT.**

10.0 TEST WITNESS

Test shall be performed in the presence of **CLIENT**. The contractor shall give at least thirty (30) days advance notice of the date when the tests are proposed to carried out.

TECHNICAL PARTICULARS

(Technical Particulars to be filled in by tenderers and enclosed along with the tender)

ITEM	**Conformations or comments or data shall be furnished by tenderer against each item**
	1010 and 500 KVA
Diesel Generating Set	
Manufacturer of DG Set	
Prime rating of DG set based on continuous operation for 365 days in a year at varying loads. The prime rating as above shall be suitable for continuous operation over an ambient of $45^{O}C$. Tenderer to categorically confirm this operation and to furnish design calculation in support of this confirmation.	
DG set to be suitable for 10% overload capacity for 1 hour on 12 hours – over and above the governor capacity being suitable.	
DG Set Dimensions (LxWxH)	
DG Set Weight (in kgs.)	
Diesel Engines:	
Manufacturer of Diesel Engine	
Manufacturers Model No.	
BHP	
RPM	
No. of Cylinder	
Type of Cooling	
Type of Starting	
Aspiration	
Air cleaner type	
Fuel/Lub Oil Filter Type	
Governor type and class	
Flywheel to suit flexible coupling	
Flexible coupling with guard	
Fuel Pump	
Hot water auxiliary pump with thermostatic control to maintain the water temperature in the engine jacked at $40^{O}C$.	
Interconnection wiring, cabling and piping as required	
Cooling water quality	
Max. engine water temperature	
Lub Oil pressure	
Max. Lub Oil temperature	
Fuel Consumption:	
Typical fuel consumption gms/BHP/hr	
50% load	

ITEM	Conformations or comments or data shall be furnished by tenderer against each item
	1010 and 500 KVA
75% load	
100% load	
Fuel consumption figures vis-à-vis alternator electrical output – kWh/litre	
50% load	
75% load	
100% load	
Fuel air compression ratio	
Suitability for locally available HSD	
Suitability of operation of DG set on cheaper fuel like LDO etc.	
Lub Oil Consumption:	
Lub oil consumption at 100% load	
Heat Balance:	
Typical heat balance	
Heat rejected to cooling water	
Heat rejected after cooler	
Heat rejected to exhaust	
Heat rejected to Ambient	
Alternator:	
Manufacturer	
Enclosure	
Mounting	
KW Rating	
KVA Rating	
Insulation class	
Temperature Rise under continuous operation	
Excitation unit	
Voltage Regulation no load to full load	
Wave from distortion on full load	
Radio Interference	
Telephone Interference	
Stator winding thermistor with trip	
Space heater	
Single step load acceptance	
Peak motor starting KVA	
Sustained short circuit % of rated current for 10 seconds	
Terminal Box (Yes/No)	
Alternator Impedance	
Anti-vibration Mounting:	
Make	

ITEM	Conformations or comments or data shall be furnished by tenderer against each item
	1010 and 500 KVA
Vibration Isolation Efficiency	
Exhaust System:	
Exhaust silencer type	
Number of Silencers provided	
Noise level dB at 1m from silencer	
Noise level 1m outside DG room and 1 m from the enclosure surface	
Exhaust pipe diameter, material and thickness	
Guaranteed Temperature on external face of exhaust pipe insulation	
Details of insulation provided for exhaust pipe	
Temperature of flue gases at exhaust manifold	
Expansion joints in exhaust piping	
Exhaust stack height – along with back pressure calculation	

Contents

PART I- GENERAL

1. SCOPE OF WORK

The general character and the scope of work to be carried out under the contract is illustrated in DBR, Drawings, Specifications and Schedule of Quantities. The Contractor shall carry out and complete the said work under this contract in every respect in conformity with the contract documents and with the direction of and to the satisfaction of the Owner's site representative. The contractor shall furnish all labour, materials and equipment (except those to be supplied by the owner) as listed under Schedule of Quantities and specified otherwise, transportation and incidental necessary for supply, installation, testing and commissioning of the complete HVAC system as described in the Specifications and as shown on the drawings. This also includes any material, equipment, appliances and incidental work not specifically mentioned herein or noted on the Drawings/Documents as being furnished or installed, but which are necessary and customary to be performed under this contract.

The system includes:

a) All refrigerant piping works including insulation, pressure testing, protection, hanging and support works for all the above-mentioned buildings.
b) All duct works including insulation, pressure testing, protection, hanging and support works for all the above-mentioned buildings.
c) Electrical and control wiring from panel to HVAC equipment.
d) Electrical wiring from panel to Outdoor and control cabling from outdoor to indoor units. Electrical wiring of indoor units.
e) SITC of all equipment that includes,
    a. VRV indoor/outdoor Unit
    b. Ventilation fan
    c. Split ac units
    d. Evaporative Cooler(Air Washer)
    e. Air Scrubber Unit
    f. Energy Recover Unit
f) Supply, installation and commissioning of Air washer, Ventilation Fans, condensing units and any other HVAC equipment/ accessories mentioned in BOQ or necessary to successfully complete the project as per clients requirements
g) Supply, installation and commissioning of related accessories for air washer.

h) Foundations for equipment including foundation bolts and vibration isolation spring/pads,
i) Suspenders, brackets and floor/wall supports for suspending/supporting ducts and pipes.
j) Suspenders and/or cable trays for laying the cables,
k) Sealing of all floor slab/ wall openings provided by the lead contractor or contractor for pipes and cables, from fire safety point of view, after laying of the same.

l) Painting of all exposed metal surfaces of equipment and components with appropriate color.
m) Making openings in the Walls/Floors/Slabs or modification in the existing openings wherever provided for carrying refrigerant pipe line, ducts, cables etc.
n) Providing wooden/ metallic frames for fixing grills/diffusers.
o) Making good all damages caused to the structure during installation and restoring the same to their original finish.

2. RELATED DOCUMENTS

These Specifications shall be read in conjunction with the General conditions of contract, schedule of work, drawings and other documents connected with the work.

PART II-APPLICABLE CODES AND STANDARDS

1. APPLICATION CODES AND STANDARDS

Supply, erection, testing and commissioning of all equipment's shall comply with the requirements of International Standards and code of practice given below as amended up to the date of submission of Tender. All equipment and material being supplied shall meet the requirements of relevant standard and codes.

A. General

ASHRAE-2011	Systems and Equipment's
ASTM D 3350, ASTM D 3035	High Density Polyethylene
BIS Code	Ducting Fabrication

B. SHEET METAL WORK:

BIS Code	Ducting Fabrication

C. NOISE & VIBRATION:

BIS /NBS Code	Preferred frequencies for acoustical measurement.
BIS /NBS Code	Code of practice for noise reduction in industrial buildings.
BIS /NBS Code	Specification for horizontal centrifugal self-priming pumps.

D. EARTHING:

BIS /NBS Code	Code of practice for earthing
BIS /NBS Code	Earthing transformer
BIS /NBS Code	Galvanized stand for earthing

E. FUSES:

BIS /NBS Code	HRC fuses links up to 650 V
BIS /NBS Code	Carrier and bases used in rewire able type electric fuses up to 650 V
BIS /NBS Code	Code of practice for maintenance of Fuses

F. MOTOR :

BIS /NBS Code	3 Phase induction motor
BIS /NBS Code	Specs for single phase small AC and universal motor
BIS /NBS Code	Code of practice for maintenance of Fuses

G. SAFETY CODES :

BIS /NBS/NFPA Code	Safety code for mechanical refrigeration
BIS /NBS/NFPA Code	Safety code for air conditioning
BIS /NBS/NFPA Code	Safety code for precaution for precaution in welding and cutting operation
BIS /NBS/NFPA Code	Code for safety procedure and practice in electrical work
BIS /NBS/NFPA Code	Code for scaffolds and ladders.

Note: All codes/ Standards with latest amendments/ Issues shall be referred.

HEATING, VENTILATION & AIR-CONDITIONING

PART III–AIR COOLED VARIABLE REFRIGERANT FLOW SYSTEM (VRV)/DX TYPE AIR COOLED SPLIT SYSTEM

A. AIR-COOLED VARIABLE REFRIGERANT FLOW SYSTEM

1.1 SCOPE

The scope of this section comprises the supply, erection testing and commissioning of inverter based Variable Refrigerant Volume System (heat pump type) with Scroll Compressor conforming to these specifications and in accordance with the requirements of Drawing and Schedule of Quantities. The VRV shall be strictly verified and co-relate with schedules.

1.2 TYPE

Units shall be air cooled heat pump type, variable refrigerant volume air conditioner of R410A gas-based consisting of outdoor unit and multiple indoor units. Each indoor units having capability to cool or heat independently for the requirement of the rooms.

It shall be possible to connect several indoor units on one refrigerant circuit. The indoor units on any circuit can be of different type and also controlled individually. Compressor installed in each modular outdoor unit shall be equipped with Scroll / rotary compressors for higher reliability, improved life, better backup and duty cycling purpose. Outdoor unit shall be suitable for mix match connection of all type of indoor units.

Following type of indoor units shall be connected to the system:

- Ductable unit
- Cassette unit
- Wall Hung Units

Both indoor units and outdoor unit shall be factory assembled, tested and filled with first charge of refrigerant before delivering at site.

The refrigerant piping between indoor units and outdoor unit shall be possible to extend up to a minimum of 165m with maximum 50m level difference without any oil traps.

1.3 OUTDOOR UNIT

The outdoor unit shall be factory assembled, weather proof casing, constructed from heavy gauge mild steel panels and coated with baked enamel finish. The unit should be completely factory wired tested with all necessary controls and switch gears:

The outdoor unit shall be modular in design and should be allowed for side by side installation. The outdoor unit shall be provided with welded steel support with two coats of paint for erection purpose.

- All outdoor units above 8 HP shall have minimum two scroll compressors and be able to operate even in case one of compressor is out of order.
- In case of outdoor units above 14HP, the outdoor unit shall have at least 2 inverter compressors and inverter motor of brushless DC Type so that the operation is not disrupted with failure of any compressor.
- It should also be provided with duty cycling for switching starting sequence of multiple outdoor units.
- The noise level shall not be more than 68 dB (A) at anechoic chamber conversion value, measured horizontally 1m away and 1.5m above ground level.
- The outdoor unit shall be modular in design and should be allowed for side by side installation
- The unit shall be provided with its own microprocessor control panel.

The outdoor unit should be fitted with low noise, aero spiral design fan with large airflow and should be designed to operate compressor-linking technology. The unit should also be capable to deliver 78 Pa external static pressure to meet long exhaust duct connection requirement wherever applicable and per drawings and schedules.
The condensing unit shall be designed to operate safely when connected to multiple fan coil units, which have a combined operating nominal capacity up to 160 % of indoor units for outdoor units up to 40 HP.

1.4 COMPRESSOR

The compressor shall be highly efficient scroll type and capable of inverter control. It shall change the speed in accordance to the variation in cooling or heating load requirement. The inverter shall be IGBT type for efficient and quiet operation.

All outdoor units shall have at least 10 to 30 steps of capacity control to meet load fluctuation and indoor unit individual control. All parts of compressor shall be sufficiently lubricated stock. Forced lubrication may also be employed. Oil heater shall be provided in the compressor casing. C.O.P for the units shall not be less than 4.5.

1.5 HEAT EXCHANGER

The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminum fins to form a cross fin coal.

The aluminum fins shall be covered by anti-corrosion resin film. The unit shall be provided with necessary number of direct driven low noise level propeller type fans arranged for vertical discharge. Each fan shall have a safety guard.

1.6 REFRIGERANT CIRCUIT

The refrigerant circuit shall include liquid & gas shut-off valves and a solenoid valve at condenser end.
All necessary safety devices shall be provided to ensure the safely operation of the system.

1.7 SAFETY DEVICES

All necessary safety devices shall be provided to ensure safe operation of the system.
Following safety devices shall be part of outdoor unit; high pressure switch, fuse, crankcase heater, fusible plug, over load relay, protection for inverter, and short recycling guard timer.

1.8 OIL RECOVERY SYSTEM

Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigeration piping lengths.

2. INDOOR UNIT

This section deals with supply, installation, testing, commissioning of various type of indoor units confirming to general specification and suitable for the duty selected. The type, capacity and size of indoor units shall be as specified in detailed Bill of Quantities

2.1 GENERAL

Indoor units shall be High static Ductable, Low Static Ductable, cassette, Wall mounted type as specified in BOQ. These units shall have electronic control valve to control refrigerant flow rate respond to lead variations of the room.

a) The address of the indoor unit shall be set automatically in case of individual and group control

b) There shall be localized control only.

2.2 The fan shall be dual suction, aerodynamically designed turbo, multi blade type, statically & dynamically balanced to ensure low noise and vibration free operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having supported from housing.

2.3 The cooling coil shall be made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/ mechanically expanded for minimum thermal contact resistance with fins. Each coil shall be factory tested at 21kg/sq.m air pressure under water.

2.4 Unit shall have cleanable type filter fixed to an integrally moulded plastic frame. The filter shall be slide away type and neatly inserted.

2.5 Each indoor unit shall have computerized PID control for maintaining design room temperature. Each unit shall be provided with microprocessor thermostat for cooling and heating.

2.6 The outdoor unit shall be pre-charged with first charge of R 410A refrigerant. Additional charge shall be added as per refrigerant piping at site. All the units shall be suitable for operation with 380 - 415 V 50 Hz + 3%, 3 Phase supply for outdoor units & 220 – 240 V, 50 Hz + 3%, 1 Phase supply for indoor units.

2.7 The units shall be integrated with Fire Alarm system and in case of fire all units shall be switched off.

2.8 The aluminum fins of Condenser Coils shall be provided with suitable factory installed protective for corrosion prevention.

2.9 The outdoor units must be suitable for up to 150m (straight length) refrigerant piping between outdoor unit & the farthest indoor units, total piping of 500m for all the indoor units. Allowable level difference between outdoor unit & indoor units shall be 50m in case of outdoor unit on top & 40 m in case of outdoor unit at bottom. Allowable level difference between various indoor units connected to one out door unit shall be up to 15m.

2.10 The outdoor unit shall employ system of equal run time for all the compressors, inverter or on/ off type, within each outdoor unit – Single Module or Multi Module.

2.11 The outdoor units shall be suitable to operate within an ambient temperature range of – 5 Deg C to 48Deg C, in cooling mode & -20 Deg C to 15 Deg C in heating mode.

2.12 Air cooled condenser shall have Axial Flow, upward throw fan, directly coupled to fan motors with minimum IP 55 protection. The outdoor unit condenser fan shall be able to develop external static pressure up to 6 mm of H2O.

2.13 The entire operation of outdoor units shall be through independent remotes of indoor units. No separate Start/ Stop function shall be required.

2.14 Starter for the Outdoor Unit compressor shall “Direct on Line” type. Inverter compressor of the unit’s hall start first & at the minimum frequency, to reduce the inrush current during starting.

2.15 Refrigerant control in the outdoor unit shall be through Electronic Expansion Valve. Complete refrigerant circuit, oil balancing/ equalizing circuit shall be factory assembled & tested.

2.16 Outdoor units shall be complete with following safety devices:

a) High pressure switch
b) Fan driver overload protector
c) Over current relay
d) Inverter Overload Protector
e) Fusible Plug

2.17 CASSETTE UNIT

a) The Cassette units shall be Ceiling-mounted type. The unit includes pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.
b) The unit must have in built drain pump, suitable for vertical lift of 750 mm.

c) Unit must be insulated with sound absorbing thermal insulation material, Polyurethane foam. The noise level of unit at the highest operating level shall not exceed 42 dB(A), at a vertical distance of 1.5 m from the grille of the unit.
d) Unit shall have provision of connecting fresh air without any special chamber & without increasing the total height of the unit.
e) The unit shall be supplied with Resin Net filter with Mold Resistance. The filter shall be easy to remove, clean & re install.
f) The unit will be connected in series to a suitable outdoor unit & it must be possible to operate the unit independently, through corded/ cordless remote specified in the "Bill of quantities".

2.18 HIGH MOUNTED UNITS WALL

The units shall be wall-mounted type. The unit includes pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.
Unit shall have an attractive external casing for supply and return air.

2.19 VRF CENTRALIZED CONTROL SYSTEM

Centralized control of the system shall be achieved via 3 user friendly compact controls: centralized remote control, unified on/off control and schedule timer. These controls may be used independently or in combination where 1 group = several (up to 16) indoor units in combination and 1 zone = several groups in combination.
A centralized remote control is for use in Hotel buildings subject to random occupation, enabling indoor units to be classified in groups per space (zoning).
The schedule timer programs the schedule and operation conditions for each tenant and the control can easily be reset according to varying requirements.

Centralized Control system shall do the below mentioned things:
a) Providing individual control of 64 groups (zones) of indoor units.
b) A maximum of 64 groups (128 indoor units, max. 10outdoor units) can be controlled.
c) A maximum of 128 groups (128 indoor units, max. 10 outdoor units) can be controlled via 2 central remote controls in separate locations.
d) Zone control.
e) Group control.
f) Malfunction code display.
g) Expanded timer function.

B. DX TYPE AIR COOLED SPLIT UNIT

1. General

The units shall be wall-mounted, Ductable, cassette unit type. The units include pre-filter, fan section and Direct Expansion (DX) coil section. The housing of units shall be light weight powder coated galvanized steel. Units shall have an attractive external casing for supply and return air. The air-cooled DX units shall match with the capacities given in schedules and drawings. The approval shall be taken before order placement from Engineer in charge.

2. INSTALLATION:

The indoor units shall be mounted on ribbed rubber pads for vibration isolation. The contractor shall supply the required charge of refrigerant, lubricant and other consumables, for commissioning and testing of the equipment.

All the equipment shall be thoroughly tested and checked for leaks. All safety controls shall be suitably set and a record of all setting shall be furnished to the project supervisor.

Providing and fixing M.S. structural support for condensing unit with vibration isolator pad in-between support and structure and vibration isolation suspender and pads for evaporating units.

3. DIMENSIONS:

Dimensions given in figures shall be taken in preference to scaled dimensions in all cases. Before commencing any work the sub-contractor shall get clarifications wherever necessary from engineer-in-charge.

4. PAINTING:

Shop coats of paint that have become marred during transportation or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop- painted surfaces.

5. CONDENSATE DRAIN PIPING:

All pipes to be used for condensate drain shall be Insulated medium class GI pipe & all joints should be Gluing or solvent cementing as per manufacturer recommendation.

6. REFRIGERANT PIPING:

i) All refrigerant pipes and fittings shall be type 'L' hard drawn copper tubes and wrought copper fitting suitable for connection with silver solder.

ii) All joints in copper piping shall be swaged joints using low temperature brazing and/or silver solder. Before joining any copper pipe or fittings, its interior shall be thoroughly cleaned be passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while construction of the joints. Subsequently, it shall be thoroughly blown out using nitrogen.

iii) Refrigerant lines shall be sized to limit pressure drop between evaporator and condensing unit to less than 0.2 kg per Sq.cm.

iv) After the refrigerant piping installation has been completed the refrigerant piping system shall be pressure tested using, Freon mixed with nitrogen at a pressure of 20 Kg per Sq. cm. (High side) and 10 Kg per Sq. cm (Low side) pressure shall be maintained on the system for a minimum of 12 hours. The system shall then be evacuated to a minimum vacuum of 70 cm. of mercury and held for 24 hours, during which time change in vacuum shall not exceed 12 cm of mercury. Vacuum shall be checked with vacuum gauge. Vacuum to be achieved using a vacuum pump. Use of compressor for vacuuming is not permitted. All refrigerant piping shall be installed strictly as per the instructions and recommendations of air conditioning equipment manufacturers.

v) The copper thickness of pipe shall be 20G/22G(0.7 to 1 mm)

vi) Sleeves shall be provided around refrigerant pipes crossing the wall and wooden partition.

vii) Refrigerant pipes should be supported on grooved wooden (teak wood only) strips suitable to accommodate insulated refrigerant pipes. The piping should be clamped to these wooden strips using a ‘C’ clamps. The distance between two supports should not be more than 5 ft.

viii) Wherever the pipes are running on the floor or exposed to view they should be covered from both side with 18 G GI tray. The tray should be supported at every 8 ft. distance using clamp supports which are painted as approved by Consultant.

ix) Refrigerant piping design for VRV system shall be submitted by the vendor for final approval.

x) Insulation should be Armaflex / K-flex/ Trocellene or equivalent make and of closed cell tubing type of specifications give in Duct insulation section.

xi) Clean the outer surface of refrigerant copper piping. Insert the pipes in tubular Armaflex/eq. Join two ends of tubular Armaflex /eq. insulation using suitable adhesive. Tape the joints with masking tapes of the same material. All outdoor piping to be protected with (For ref. Piping,) Woven Fiberglass cloth, 7 mil thickness and 200 gsm weight, with factory laminated, self-adhesive backing should be used. This needs to be finished with 2 coats of UV painting.

7. POWER SUPPLY:

Power supply near the indoor unit will be provided from the Socket/Main LT panel using Distribution Boards (DBs) by lead contractor with suitable MCBs.

Power supply from MCB to indoor unit and from outdoor unit to Indoor unit to be provided by the sub-contractor along with earthing.

PART IV–FACTORY BUILT AIR HANDLING UNIT (AHU)/ CEILING SUSPENDED UNIT/HEAT RECOVERY UNIT

1. SCOPE

This chapter covers the detailed requirements of factory built double skin air handling unit (AHU). The configuration and details of each AHU shall be verified and co-related with individual building schedule.

2. FACTORY BUILT AIR HANDLING UNIT (AHU)

2.1 TYPE

The air handling unit shall be of double skin construction, draw through type in sectionalized construction consisting of blower section, coil section, humidification section (where specified), filter section and drain pan. Unless otherwise specified, the unit shall be horizontal type.

2.2 RATING

i) The capacity of the DX coil, the air quantity from the blower fan and static pressure of blower fan shall be as laid down in the tender documents. Where these parameters as calculated by the tenderer exceed the specified values, the coils and the blower fan shall satisfy these calculated values.
ii) The coil shall be designed for a face velocity of air not exceeding 450 FPM.
iii) The requisite static pressure demanded by the air circuit shall be developed by the fan at the selected operating speed. The static pressure value shall not in any case be less than the static mentioned in BOQ. The fan motor HP shall be suitable to satisfy these requirements and the drive losses.
iv) The air outlet velocity from the blower fan shall not exceed 610 m/min.
v) Noise level at a distance of 3M from AHU shall not exceed 70dBA.

2.3 MATERIAL AND CONSTRUCTION

a) HOUSING / CASING

i) The housing/ casing of the air handling unit shall be of double skin construction. The housing shall be so made that it can be delivered at site in total semi knocked down conditions depending upon the requirements. The main framework shall be of suitable structural sections. The entire framework shall be assembled using mechanical joints to make a sturdy and strong framework for various sections. Framework of all air handling units shall be made of thermal break hollow extruded aluminum profile. **In case of AHU casing design with no contact between inner and outer surface, thermal break profiles can be avoided.**

ii) Double skin panels shall be minimum 46 ± 2mm thick made of 0.8mm pre-plasticized and pre-painted with PVC guard, GSS sheet on outside and 0.8mm galvanized sheet inside with polyurethane foam insulation of density not less than 38 kg/cum injected in between by injection moulding machine. These panels shall be joined and connected to the framework/ supports with soft rubber gasket in between (if necessary) to make the joints airtight and low air leakage potential. The gaskets shall be inserted within groove in extruded aluminum

profile of the framework. For units installed outdoor, the thickness of double skin panels shall be minimum 40 mm.

iii) Frame work for each section shall also be joined together to make the joints air tight. Suitable doors with nylon handles and all access panels should be operable with allen key/ suitable locking arrangement. Aluminum die-cast powder coated/ Nylon hinges & latches shall be provided for access to various panels for maintenance. However, AHU in the form of complete single unit shall also be acceptable with access door(s) for maintenance to various sections. The entire housing shall be mounted on galvanized steel channel frame work made out of G.I. sheet of thickness not less than 2mm. For higher capacity AHUs hot dip galvanized steel channel framework made of minimum 3 mm thick G.S. sheet shall be used.

b) DRAIN PAN

Drain pan shall be made out of minimum 1.25 mm stainless steel sheet externally insulated (If Drain pan is outside the unit), with 10mm thick closed cell Polyethylene foam/ equivalent suitable insulation with necessary dual slope to facilitate fast removal of condensate. Necessary supports will be provided to slide the coil in the drain pan.

c) COOLING COIL

i) The coil shall be made from seamless solid drawn copper tubes. The minimum thickness of tube shall be 0.41 mm for cooling / heating / heating-cum-cooling coils.
ii) The depth of the coil shall be such as to suit the requirements, viz. re-circulated air applications, or 100 % fresh air applications and the bypass factor required shall be specified in the tender specifications. The coil shall be 4 or 6 rows deep for normal re-circulated air application and 8rows deep for all outdoor air application, unless otherwise specified in the tender specifications. In case of 8 rows deep coils, it shall be made of 2x4 rows deep coils with a spacing of 200 mm between the two coils, access door and independent drain pan.
iii) U bends shall be of copper, jointed to the tubes by brazing, soft soldering shall not be used.
iv) Each section of the coil shall be fitted with flow and return headers to feed all the passes of the coil properly. The headers shall be of copper and shall be complete with refrigerant in/out connections, vent plug on top and drain at the bottom. The coil shall be designed to provide water velocity between 0.6 to 1.8m/s in the tubes.
v) The fins shall be of aluminum. The minimum thickness of the fins shall be 0.15 mm nominal. The no. of fins shall not be less than 4-5 per cm length of coil. Fins may be of either spiral or plate type. The tubes shall be mechanically expanded to ensure proper thermal contact between fins and tubes. The fins shall be evenly spaced and upright. The fins bent during installation shall be carefully realigned. For coastal areas fins shall be phenolic coated and for 100% FA application fins shall be hydrophilic type.
vi) The coil shall be suitable for use with the refrigerant specified or with water as the case may be. Refrigerating coils shall be designed for the maximum working pressure under the operating conditions. Water coils shall be designed for a maximum working pressure of 10 kg./sq.cm.
vii) Shut off and regulating valves at the inlet and outlet of water shall be provided. In the case of Direct Expansion (DX) coils, solenoid valve and expansion valves shall be provided at the inlet of coil.

d) SUPPLY AIR FAN AND DRIVE

i) The supply air fan shall be AMCA certified centrifugal type with forward/ backward curved blades double inlet double width type or Plug type direct driven aerofoil backward curved fans. For static pressure upto 65mm forward curved blades shall be used and for higher sizes backward curved blades shall be used in case of Double Inlet Double width(DIDW) fans.

ii) The fan housing of Galvanized sheet steel and the impellers shall be fabricated from heavy gauge steel sheet as per approved manufacturer's standard. The side plates shall be die-formed for efficient, smooth airflow and minimum losses. Fan impeller shall be mounted on solid shaft supported to housing using heavy duty ball bearings. Fan housing and motor shall be mounted on a common extruded aluminum base mounted inside the fan section on anti-vibration spring mounts or cushy-foot mount. The fan outlet shall be connected to casing with the help of fire retardant fabric.

iii) The fan impeller assembly shall be statically and dynamically balanced.

iv) If belt drive is applicable, the fan shall be fitted with V belt drive arrangement consisting of not less than two evenly matched belts. Belts shall be of oil resistant type. Adequate adjustments shall be provided to facilitate belt installation and subsequent belt tensioning by movement of the motor on the slide rails. A readily removable door guard shall be provided.

v) The fan motor shall be totally enclosed fan cooled squirrel cage induction motor with IP-54 protection &selected for quiet running. The motor shall be suitable for operation on 415 ± 10%V, 3phase, 50 Hz, A.C. supply. **The motor shall have efficiency class IE-3.**

e) AIR FILTERS

The air used in an air-conditioning system must be filtered to maintain a clean atmosphere in the conditioned space. The concentration of contaminants in the air and the degree of cleanliness required in the conditioned space will determine the type of filter or filters that must be used.

f) TYPE OF FILTERS

i) **Pre-filters:** Cleanable metallic viscous type filter made out of aluminum wire mesh or of dry cleanable synthetic type minimum 50mm thick, shall be provided on the suction side of AHU as standard equipment with the unit. These filters shall have the efficiency of 90% down to 10-micron particle size. When these filters become loaded or full of dirt, it is removed from service and replaced by another filter. The dirty filter can then be washed in a cleaning solution in a tank, dried and then given a bath of viscous oil. Face velocity across these filters shall not exceed 155 MPM.

ii) **Fine-filters:** These filters shall have efficiency of 99% down to 3 micron particle size as per standard. These Filter are provided on the discharge side of AHU after fan section and are always backed by pre-filters provided on the suction side of AHU. Face velocity across these filters shall not exceed 450 FPM.

iii) **Ei-filters:** Ei-filter is advanced air purification technology which removes harmful substances like dust particles, allergens, pollen, smoke, bacteria, virus and other airborne particles. The filter should be designed with low pressure drop and should have impingement, polarization and agglomeration principles. The e-filter shall be able to remove 97% of airborne particles down to 0.3 microns and greater in recirculating system

with the pressure drop loss of not more than 0.2 w.g @ 300 fpm. The thickness of the filter should be 50mm and the performance should be correspondence to PM2.5 filteration. The filter should be able to integrate with pre-engineered indoor type ductable/cassette/ Hi Wall unit system. The media should be throw away type only. Washable type media will not be accepted due to its low efficiency. It must be applied in line with the manufacturer's instructions and guidelines in the finished manner.

g) GENERAL CONSTRUCTION OF FILTERS

i) Each AHU shall be provided with a factory assembled filter section containing pre-filters made of cleanable metal viscous filters made of corrugated aluminum wire mesh, or dry cleanable synthetic filters. These shall be minimum 50 mm thick with a frame work of aluminum/GI.
ii) The filter area shall be made up of panels of size convenient for handling. The filter panels shall be held snugly within suitable aluminum framework made out of minimum 1.6 mm GI/ aluminum sheet with sponge neoprene gaskets by sliding the panels between the sliding channels so as to avoid air leakage.
iii) In order to indicate the condition of these filters while in operation, a manometer shall be provided to indicate the pressure drop across the fine filters and absolute filters.
iv) Special filters, if any specified in the tender specifications shall be provided in addition to the above filters. In that event, the latter shall function as pre-filters.
v) Each filter shall carry test certificate from manufacturer.

2.4 INSTALLATION

The air handling unit shall be so installed as to transmit minimum amount of vibration to the building structure. Adequate vibration isolation shall be provided by use of rubber/ neoprene pads and/or vibration isolation spring mountings.

3. HEAT RECOVERY UNITS

3.1 SCOPE

The scope of this section comprises of the supply of double-skin "Heat recovery Units conforming to the following specifications.

3.2 TYPE

The Heat recovery units shall be two stream units in double skin construction thermal break, comprising of supply air section, return air section and Heat Recovery Section. The supply air section shall include Inspection Section.

3.3 CAPACITY

The Heat recovery units shall be of such capacities and static pressures as mentioned in the Bill of Quantities and schedules.

3.4 CASING

i) The housing/ casing of the heat recovery unit shall be of double skin construction. The housing shall be so made that it can be delivered at site in total semi knocked down conditions depending upon the requirements. The main framework shall be of suitable structural sections. The entire framework shall be assembled using mechanical joints to make a sturdy and strong framework for various sections. Framework of all heat recovery units shall be made of thermal break hollow extruded aluminum profile. In case of HRU casing design with no contact between inner and outer surface, thermal break profiles can be avoided.

ii) Double skin panels shall be minimum 43±2 mm thick made of 0.8mm (Both inner and outer Sheets) with polyurethane foam insulation of density not less than 38 kg/cum injected in between by injection moulding machine. These panels shall be joined and connected to the framework/ supports with soft rubber gasket in between (if necessary) to make the joints airtight and low air leakage potential. The gaskets shall be inserted within groove in extruded aluminum profile of the framework. For units installed outdoor, the thickness of double skin panels shall be minimum 43±2 mm.

iii) Frame work for each section shall also be joined together to make the joints air tight. Suitable doors with nylon handles and all access panels should be openable with Allen key/ suitable locking arrangement. Aluminum die-cast powder coated/ Nylon hinges & latches shall be provided for access to various panels for maintenance. However, AHU in the form of complete single unit shall also be acceptable with access door(s) for maintenance to various sections. The entire housing shall be mounted on galvanized steel channel frame work made out of G.I. sheet of thickness not less than 2mm. For higher capacity AHUs hot dip galvanized steel channel framework made of minimum 3 mm thick G.S. sheet shall be used.

The Inspection and access panels shall be hinged type. The hinges shall be casted, powder coated Zinc alloy. Flushed Locks and Handles shall be of galvanized steel. Other panels will be screwed on to the frame with sealant and soft rubber gasket thus making the joints air tight. All screws used for panel fixing shall be covered with PVC caps.

Special gaskets and seals shall be used on inspection doors and to create separation between the airstreams to ensure negligible air leakage and mixing.

3.5 SUPPLY AIR SECTION

The supply air section shall comprise of the following:-

a) FAN SECTION

The fan shall be centrifugal forward curved or backward curved, double inlet double width type. The impeller and the fan casing shall be made of hot galvanized sheet steel. The impeller shall be mounted on a solid shaft supported to housing with angle iron frame and pillow block heavy duty ball bearing. The impeller shall be statically and dynamically balanced. The fan shall be selected such that unit noise level is less than 85 db. Fan housing and motor shall be mounted on a common galvanized steel or aluminium block base which can be drawn out from side for ease of maintenance. A quarter pin lock arrangement between the slide and guide pin lock arrangement between Fan and Unit outlet should be provided.

b) MOTOR AND DRIVE

Fan motor shall be energy efficient with efficiency level of IE-3 or EFF1 whichever is more efficient and suitable for 415 10% volts, 50 cycles, 3 phase squirrel cage, totally enclosed fan cooled with IP – 55 protections. Motor shall be designed for quiet operation. Drive shall be provided through belt – drive arrangement. Belts will be of oil resistant type.

c) FILTER SECTION (Pre Filter (in supply only))

The air used in an air-conditioning system must be filtered to maintain a clean atmosphere in the conditioned space. The concentration of contaminants in the air and the degree of cleanliness required in the conditioned space will determine the type of filter or filters that must be used.

d) TYPE OF FILTER

Pre-filters: Cleanable metallic viscous type filter made out of aluminum wire mesh or of dry cleanable synthetic type minimum 50mm thick, shall be provided on the suction side of AHU as standard equipment with the unit. These filters shall have the efficiency of 90% down to 10 micron particle size. When these filters become loaded or full of dirt, it is removed from service and replaced by another filter. The dirty filter can then be washed in a cleaning solution in a tank, dried and then given a bath of viscous oil. Face velocity across these filters shall not exceed 155 MPM.

e) DAMPER SECTION

Damper section shall contain a built-in damper of aluminum profile with leakage class III. The damper blades shall be connected with plastic gear wheels with a gasket of silicon rubber to produce tightness between the blades.

f) DRAIN PAN

Drain pan shall be made out of minimum 1.25 mm stainless steel sheet externally insulated (If Drain pan is outside the unit), with 10mm thick closed cell Polyethylene foam/ equivalent suitable insulation with necessary dual slope to facilitate fast removal of condensate.

g) INSPECTION SECTION

The Inspection section shall be for inspection of other functional sections. It shall be available in two options; long and short version and shall be selected as defined in the Bill of Quantities.

3.6 RETURN AIR SECTION

a) FAN SECTION

The fan shall be centrifugal forward curved or backward curved, double inlet double width type. The impeller and the fan casing shall be made of hot galvanized sheet steel. The impeller shall be mounted on a solid shaft supported to housing with angle iron frame and pillow block heavy duty ball bearing. The impeller shall be statically and dynamically balanced. The fan shall be selected such that unit noise level is less than 85 db. Fan housing and motor shall be mounted on a common galvanized steel or aluminium block base which can be drawn out from side for ease of maintenance. A quarter pin lock arrangement between the slide and guide pin lock arrangement between Fan and Unit outlet should be provided.

b) MOTOR AND DRIVE

Fan motor shall be energy efficient with efficiency level of IE-3 or EFF1 whichever is more efficient and suitable for 415+10% volts, 50 cycles, 3 phase squirrel cage, totally enclosed fan cooled with IP – 55 protections. Motor shall be designed for quiet operation. Drive shall be provided through belt – drive arrangement. Belts will be of oil resistant type. The drive and motor shall be provided outside the air path.

The tank shall be of stainless-steel sheet of thickness not less than 1.6mm, having necessary arrangement for inlet water with float valve over flow and drain arrangement.

3.7 HEAT RECOVERY SECTION

The Heat Recovery section shall include enthalpy wheels and shall have minimum recovery of 75 % of total heat, i.e both sensible and latent (each being 75 %). The recovery of sensible and latent shall be equal. Necessary computerized selection of the wheel should be provided along with the bid to justify the same. The wheel shall be made of pure aluminum foil coated with molecular sieve desiccant with pore diameter of 3oA.The cross contamination between the two air streams shall be nil and leakage less than 0.04%. The vertical and radial run of the wheel shall be less than 1 mm per meter of diameter. The wheels shall have non-contact labyrinth seals for effective sealing between the two air streams.

Detailed specification for the wheel shall be as per 8.0 i.e., "HEAT RECOVERY WHEEL"

i) **HEAT RECOVERY WHEEL SPECIFICATIONS:**

The substrate or wheel matrix should be only of pure aluminum foil so as to allow.

a) Quick and efficient uptake of thermal energy.

b) Sufficient mass for optimum heat transfer

c) Maximum sensible heat recovery at a relatively low rotational speed of 20 to 25 rpm.

- Non-metallic substrates made from paper, plastic, synthetic or glass fiber media, will therefore, not be acceptable.
- The substrate shall not be made from any material which is combustible or supports combustion like synthetic fibrous media.
- The wheel has to be certified as per DIN EN ISO 846 with 0% fungal and bacterial growth at 95% Relative humidity and above.
- The minimum depth of the Wheel shall be 250 mm.
- The pressure drop across the rotary heat exchanger shall not exceed 0.1 inch for every 100 FPM face velocity, or part thereof, for the minimum stated/ required latent recoveries / efficiencies

NECESSARY SOFTWARE SELECTION OF THE WHEEL HAS TO BE ENCLOSED TO JUSTIFY THE PRESSURE DROP AND EFFICIENCY CALCULATIONS.

ii) **THE DESICCANT**

The desiccant should be water molecule selective and non-migratory.
The desiccant should be molecular sieve 3Å so as to keep the cross contamination to absolute minimum and also ensure the exclusion of contaminants from the air streams, while transferring the water vapour molecules.

The desiccant, of sufficient mass which should not be less than 5 kg per 1000 cfm of air, should be coated with non-masking porous binder adhesive on the aluminum substrate so as to allow quick and easy uptake and release of water vapour. A confirmation has to be provided by

manufacturer of wheel to this effect. A matrix with desiccants impregnated in non-metallic substrates, such as synthetic fibre, glass fibre, etc. will not be accepted.

a) Rotor:
With optimum heat and mass through matrix formed by desiccant, of sufficient mass, the rotor should rotate at lower than 20 to 25 RPM, thereby also ensuring long life of belts and reduced wear and tear of seals.

The rotor honeycomb matrix foil should be so wound and adhered as to make a structurally very strong and rigid media which shall not get cracked, deformed etc. due to change of temperature or humidity.

The rotor having a diameter up to 2800 mm shall have spokes to reinforce the matrix. From 2000 mm diameter upwards, the option of a special wing structure, to prevent the rotors from wobbling or deforming due to the successive pressure differentials, will be available.

Sectioned wheels, with pie segments, capable of being assembled in the field, shall be available as an option, above 2000 mm in diameter.
The surface of the wheel/rotor should be highly polished to ensure that the vertical run out does not exceed + 1 mm for every 1-meter diameter, thereby ensuring, negligible leakage, if labyrinth non-contact seals are provided, and minimal drag, if contact wiper seals are provided.

The radial run out also shall not exceed + 1 mm for every 1 meter diameter, thereby minimizing the leakage/drag on the radial seals, and minimizes the fluctuation in the tension of the drive belt.

The number of wraps for every inch of rotor radii shall be very consistent so as to ensure uniform air flow and performance over the entire face in the air stream. Flute height and pitch will be consistent to a very tight tolerance to ensure uniform pressure drop and uniform airflows across the rotor face.

The media shall be cleanable with compressed air, or low-pressure steam or light detergent, without degrading the latent recovery.

b) The Cassette / casing
The recovery wheel cassette/casing shall be manufactured from corrosion resistant tubular / sheet metal structure to provide a self-supporting rigid structure, complete with access panels, purge sector, rotor, bearings, seals, drive mechanism complete with belt.
The rotor/wheel should have a field adjustable purge mechanism to provide definite separation of airflow minimizing the carryover of bacteria, dust and other pollutants, from the exhaust air to the supply air. It shall be possible, with proper adjustment, to limit cross contamination to less than 0.04% of that of the exhaust air concentration.

The face and radial seals shall be four (4) pass non-contact labyrinth seals / brush seals for effective sealing between the two air streams, and also for a minimum wear and tear ensuring long life of the seals.

Bearings: the bearing shall be permanent lubricated corrosion resistant Stainless steel or self-lubricating engineering plastics.

Drive Mechanism: The unit shall be provided with complete drive mechanism having drive motor, drive belt and auto belt tension.

PART V: FACTORY BUILT FLOOR MOUNTED AIR WASHER/AIR SCRUBBER

1. FACTORY BUILT FLOOR MOUNTED AIR WASHER

1.1 SCOPE

This chapter covers the detailed requirements of factory built double skin air washer unit (AWU). The configuration and details of each AWU shall be verify and co-related with individual building schedule.

1.2 FLOOR MOUNTED AIR WASHER UNIT

1.2.1 GENERAL

The air washer unit shall be complete in all respect and shall generally comply with the following specifications given below:

1.2.2 AIR WASHER UNIT

The Air Washer unit shall be Double skin outdoor mounted type made of 50mm thick panels consisting of GI casing of thickness 0.63mm outside layer precoated and 0.63mm inside layer plain with factory injected PUF insulation, Supply & Return air Screw blower(Forward curved/backward curved)sections constructions,, belt drive packages with TEFC motor suitable for operation on 415 +/- 10% volts, 50 Hz, 3 phase, A.C. power supply, Fresh air Pre-filter section, Supply air dampers with suitable actuator for each unit and all the necessary accessories, necessary vibration isolators and complete as per specifications. Unit shall have total static pressure of 50 mm of WG. of GI sheet metal sectionalized construction and shall include fan section, Pre- filter , motor drive etc.

a) Section:

The fan housing shall be of sturdy construction made from double skinned GSS casing having 0.63 mm precoated GI sheet outside and plain 0.63 mm thick GI sheet inside with 50 mm thick puff insulation with smooth air inlets. The fan shall be mounted on properly aligned shaft and mounted on self-aligning bearing blocks. The casing of the cab section shall be made of 16 G (1.6mm) GI sheets suitably reinforced to provide rigidity. The frame work shall either be folded G.I. sheets or of hot dipped galvanized iron.

The fan section shall be complete with V belt drive, belt guard and motor mounting base.

b) Fan Section:

The impellers of the fan or fan shall be of GI sheets, double inlet backward curved Screw design, both statically and dynamically balanced. The fan housing shall be of sturdy construction made from double skinned GSS casing having 0.8 mm pre coated GI sheet outside and plain 0.8 mm thick GI sheet inside with 25 mm thick puff insulation with smooth air inlets. The fan shall be mounted on properly aligned shaft and mounted on self-aligning bearing blocks. The casing of the cab section shall be made of 16 G (1.6mm) GI sheets suitably reinforced to provide rigidity. The frame work shall either be folded G.I. sheets or of hot dipped galvanized iron.

The fan section shall be complete with V belt drive, belt guard and motor mounting base.

c) Cooling Pad:

The cooling pads shall be of honey comb design to provide extended and sufficient wetted surface to give a water absorbing efficiency of at least 80% at an air velocity of 500 FPM (3.0 m/sec.).

The cooling pads shall be made of either acetate paper or high impact PVC. The cross section and depth shall be sufficient for specified efficiency. The cooling pad section shall be of 16 G (1.6mm) G.I. sheet similar to fan section. It shall be complete with galvanized supports for mounting the pads and a water distribution through the uniform supply of water over the entire surface.

d) Water Sump:

The water sump below the pad section shall be of 20-gauge SS 304. The tank shall be complete with makeup, overflow and drain connections. A float valve shall be provided for makeup water line.

The pump set shall be of construction, with end suction and top discharge with flanged connections, bronze impeller and casing all mounted directly on a squirrel cage, drip proof induction motor of suitable capacity.

e) Air filter

The standard pre-filters shall be with 5 layers of G.I. wire mesh, fixed in A 24 G G.I. Frame with handles for ease of removal.

The above set of filters shall be fixed in filter frames made of 22 G.I. sheets, shaped to prevent air leakage. The filters shall be easily removable. The filter section may from part of the pad section or may be bolted separately to the pad section.

1.2.3 MOTORS

The motor for each blower, shall be totally enclosed, fan cooled, squirrel cage induction type and conform to specifications as given under section 3.The starters shall be “direct on line” type up to 7.5 H.P. All larger starters shall be of fully automatic star delta type. The pumps shall be provided with single phase, self-tripping starter of North West make.

1.2.4 MISCELLENOUS

Necessary accessories shall be provided wherever necessarily required for proper operation and shall also include:

a) Necessary GI piping for water circulation
b) Vibration isolations pads for the blowers and pumps
c) Canvass connections at the outlet of each fan
d) Nuts, bolts, shims etc. as required for the grouting of the equipment
e) Float valves in the air washer tank, along with quick fill connection

1.2.5 LIMITATION

The air velocity limits are as follows:

a) Average velocity across air washer filters shall not exceed 2.5 m/sec (500 FPM)
b) Velocity at blower outlet shall not exceed 10 m/sec (2000 FPM)

2. ELECTROSTATIC AIR CLEANERS (ESP/ DRY SCRUBBERS) FOR KITCHEN EXHAUST

2.1 Equipment Description:

The Electrostatic Air Cleaners shall be supplied as a one-piece factory joined assembly of individual section(s) selected to treat oil mist, smoke, fume, grease & dust/ powder problems.

2.2 Unit Housing:

Housing shall be constructed with minimum 1.6mm thick steel sheet with reinforced structure & powder coated to protect against rust and corrosion. It shall have a hinged door for cell access, located one side of the unit. The door shall be gasketed to prevent air leakage. There shall be a safety interlock switch to cut off primary supply when the access door is opened.

2.3 Finish:

The external finish shall be a durable industrial grade semi-gloss epoxy-polyester coating suitable for outdoor installations.

2.4 Ionizing-Collecting Cells:

Ionizing-Collecting cell(s) shall be of one-piece construction 13.38" (340mm) deep in direction of airflow. The dimension of the collection cell shall be 18.89" (480mm) H x 19.76" (502mm) W Max. All support framing, end plates and ionizer ground electrodes shall be 0.080 inch (2mm) thick aluminum. Both repelling and collector plates shall be 0.032 inch (0.8mm) thick aluminum alloy material rigidly retained in place with tubular spacers and tie rods. Each plate shall be corrugated, perpendicular to airflow direction. Spacing between plates shall be no less than 0.318 inch (8mm). Each cell shall weigh at least 17 kg with at least 8 stainless steel spiked blade ionizers. Tungsten wire ionizers will not be accepted.

2.5 Ionizer

Ionizing spiked blade shall be made of Stainless steel 304 material, rigidly supported both vertically and laterally. Spiked ionizer to ground electrode spacing shall be 1.0" (25mm). High voltage support insulators shall be of Teflon material for dielectric strength. Tungsten wire Ionizers will not be accepted.

2.6 Air handling Capacity

Equipment should be selected based on required Air handling capacity so as to achieve 90-95%

particulate matter removal efficiency according to DOP Test or EN779 European standard (Equivalent to ASHRAE 52.1). Vendor should submit the Test report from the Lab having Test facility according to ASHRAE 52.2 or EN779. In the absence of Test Report Vendor should demonstrate the efficiency claim at their manufacturing facility at their expenses.

2.7 Power Supply

Power supplies shall be 100% solid state, operate on 230 VAC, 50 Hz, 1 Phase input and provide a dual high voltage output of 12-13 KVDC for the ionizer and 6.0-6.5 KVDC for the collector in normal operation conditions. Current output at the high tension shall be 12mA. A maximum power output for the solid-state power supply shall be 120 watts to maintain the specified collection efficiency. Integrally mounted Electrical interlocks shall be provided to prevent access to the high voltage components without first interrupting the primary input power. The power supply shall operate over a temperature range of -32 degrees F to 140 degrees F, be overloaded self-protecting and accommodate an LED light indicating the performance status of the ionizing/collecting cell. High voltage output components in the power supply shall be sealed with epoxy for moisture resistance.

2.8 Outstanding Features

The power pack shall incorporate a short circuit arc protection with automatic power restoration system to prevent overload.

2.9 Performance Indicator Lights

There shall be 2 LED lights (Green & Red) installed on the access door of the unit to indicate the status of the air cleaning system.

2.10 BMS (Building Management System) interface

The power supply (pack) shall have a 2 wire dry contacts (NO/NC) for remote link to Building Management System. This is for performance indication of the air cleaning system.

2.11 Electrical:

Factory wiring will be in accordance with the National Electrical Code. Required field wiring shall conform to the National Electrical Code and any local code requirements. The manufacturer shall be informed of any local variances to the National Electrical Code.

PART VI - DUCTING

1. SHEET METAL WORK

A. FACTORY FABRICATED (As per SMACNA):

This section deals with supply, erection, testing & balancing of GI sheet metal duct work and air registers conforming to specifications as given below:

Material for Ducting

All the ducts shall of LFQ (Lock Forming Quality) grade prime G.I. raw material furnished with accompanying Mill Test Certificates. Galvanizing shall be 120gms/sq.m. (total coating on both sides).

In addition, if deemed necessary, sample of raw material, selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

The G.I. raw material should be used in coil-form (instead of sheets) so as to limit the longitudinal joints at the edges only, irrespective of cross-section dimensions.

Governing Standards:

Unless otherwise specified here, the construction, erections, testing and performance of the ducting system shall conform to the SMACNA standards and Addendum of SMACNA

Duct connectors and Accessories:

All the transverse duct connectors (Flanges\Cleats) and accessories related hardware such as support system shall be zinc coated (galvanized).

Fabrication standards:

All the ductwork including straight sections, tapers, elbows, branches, shoe pieces, collars, terminal boxes and other transformation pieces shall be factory-fabricated. Equivalency will require fabrication by utilizing the following machines and process to provide the requisite quality of ducts and speed of supply.

Coil lines to ensure location of longitudinal seams at corners\folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any side of the ducts.

All ducts, transformation pieces and fittings shall be made on CNC profile cutters for required accuracy of dimensions, location and dimensions of notches at the folding lines.

All edges shall be machines treated using lock-formers and rollers for furring up edges.

Selection of G.I. and Transverse Connectors:

Duct construction shall be in compliance with 1" (250 Pa) w.g. static norms as per SMACNA.

All transverse connectors shall be 4-bolt system.

To avoid any leakage additional sealant shall be used.

The specified class of transverse connectors and duct gauge for a given duct dimensions shall be 1" (250 Pa) pressure class.

Non-toxic, AC-application grade P.E. or PVC gasketing shall be provided between all mating flanged joints. Gasket sizes shall conform to flange manufacturer's specification.

Duct construction

The fabricated duct dimensions shall be as per approved drawings and all connecting sections shall be dimensionally matched to avoid any gaps.

Dimensional Tolerances: All fabricated dimensions shall be within + 1.0mm of specified dimension. To obtain required perpendicularity, permissible diagonal tolerance shall be +1.0mm per meters.

Each duct pieces hall be identified by coded sticker, which shall indicate specific part number, job name, drawing number, duct sizes and gauge.

Ducts shall be straight and smooth on the inside. Longitudinal seams shall be airtight and at corners, which shall be either Pittsburgh or snap button punch as per SMACNA practice, to ensure air tightness.

Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7) turning vanes or air splitters shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.

Plenum shall be factory fabricated panel type and assembled at site.

Factory fabricated ducts shall have the thickness of the sheet as follows and length of the piece not more than 1200mm and should have beading at every 300mm.

Recommended SMACNA standard at 4 feet Transverse Joint Reinforcement

Duct Static Pressure In Inches	**1”**	**2”**	**3”**	**4”**	**6”**
Duct Size (mm)					
150-250	B-26	B-26	B-26	B-26	C-26
251-300	B-26	B-26	B-26	C26	C-24
301-350	B-26	C26	C26	C26	C-24
351-400	B-26	C26	C26	D-26	D-24
401-450	C26	C26	C26	D-26	E-24
451-500	C26	C26	D-24	D-24	E-24
501-550	C26	C26	D-24	E-24	F-22
551-600	C26	D-26	E-24	E-24	F-22
601-650	C26	D-26	E-24	E-24	F-22
651-700	C26	D-26	E-24	F-22	G-22 R
701-750	C26	E-24	E-24	F-22	G-20
751-900	D-26	E-24	F22	G-22 R	H-20 R
901-1000	E-24	F-22	G-22R	H-20 R	I-18
1001-1200	E-24	G-22	H-20R	I-18	I-18
1201-1300	F-22	H20	I-18	I-18	J-18 R

1301-1500	F-22	H-20 R	I-18	I-18 R	-
1501-1800	H-22	I-18	J-18 R	-	-
1801-2100	I-20	J-18 R	-	-	-
2101-2400	I-18	J-18 R	-	-	-
2401-2700	I-18	-	-	-	-

NNote: SMACNA- sheet Metal & Air Conditioning Contractor National Association Inc. "HVAC Duct construction standard metal & flexible"- Third Edition 2005 USA.

In 1" static pressure i.e., comfort cooling application optional "C&S and C&SS cleats joints can be used

Up to 450mm duct size use C&SS cleats.

Over 750 mm duct size use TDF/TDC flanges with respective gauges as mentioned above.

Alphabets B,C,D,E,F,G,H,I and j per SMACNA 2005, transverse joint reinforcement table 1-12m (T-25b flanged) and TDC addendum.

R means reinforcement with Zee bar Stiffener / Joint Tie Rod /Mid Tie Rod.

The gauges, joints and bracing for sheet metal ductwork shall further conform to the provisions as shown on the drawings.

Ducts larger than 600 mm shall be cross broken, duct sections up to 1200 mm length may be used with bracing angles omitted

Changes in section of duct work shall be affected by tapering the ducts with as long a taper as possible. All the branches shall be taken off at not more than 45 DEG. Angle from the axis of the main duct unless otherwise approved by the Engineer-in-charge.

* Ducts 2250 mm and larger require special field study for hanging and supporting methods.

In addition to above the following points should be also taken into account while fabrication of ducts.

a) All ducts of size larger than 450mm shall be cross broken.
b) All ducts shall be supported from the ceiling / slab by means of MS rods of dia 9mm with MS angle of size 40 x 40 x 5 mm at the bottom with neoprene pad in between the duct & MS angle. The ducts shall be suspended from the ceiling with the help of dash fasteners. Provision for necessary ancillary materials required for hanging the ducts shall be arranged by the contractor.
c) The vanes shall be provided wherever required and shall be securely fastened to prevent noise & vibration.
d) The rubber gasket shall be installed between duct flanges in all connections and joints.
e) All flanges and supports should be primer coated.

f) The flexible joints shall be fitted to the delivery side of AHU fans with Fire Retardant Double canvass. The length of flexible joints should not be less than 150 mm and not more than 300 mm between faces.
g) The ducting work can be modified if deemed necessary in consultation with the Engineer in Charge to suit actual site conditions in the building.
h) Box Type Dampers & Splitters

These dampers shall be provided in the ducting work for proper control and balancing of air distribution. All dampers shall be louver type robust construction. These dampers shall be fitted with easily accessible operating mechanism, complete with links, levers, quadrant for proper control and setting in a desired position. The position of the handle of the damper operating mechanism shall be clearly visible and shall indicate the position of the damper in the duct. All dampers, splitters shall be fabricated out of G.S. sheet of two gauges higher than the duct piece having these fittings. Dampers shall be installed in duct at all required locations. No extra payment shall be made separately since these form part of Air Circulation System.

NOTE: In case angle iron supports are not feasible to be installed for supporting the ducts due to height constraint then the contractor shall support the ducts with M.S flats of at least double the thickness of the angle iron supports.

B. SHEET METAL DUCT (SITE FABRICATED):

i) GENERAL:

Supply, fabrication, installation and testing of all sheet metal ducts & supply, installation, testing and balancing of all grilles, registers and diffusers, in accordance with these specifications and the general arrangement shown on the drawings.

Duct work shall mean all ducts, casings, dampers, access doors, joints, vanes, stiffeners, hangers and supports etc.

All ducts shall be fabricated according to ASTM 525A from galvanized steel sheets of zinc grade G27 or Z90 of the following thickness as indicated in schedule of quantities & as described in the relevant code.

ii) RECTANGULAR DUCT:

Dimensions of Ducts	GI sheet		Type of Joints	Type of Bracing
	Thickness (mm)	Gauge		
Upto 600	0.63	24	G.I. Flange at 2.5 Centre	Cross Bracing
601 to 750	0.63	24	-------	------
751 to 1000	0.63	24	25x25x3mm angle iron frame with 6mm dia nuts and bolts.	25x25x3mm M.S. angle bracing at 1500mm from joints.
1000 to 1500	0.80	22	25x25x3mm angle iron frame with 8mm dia	25x25x3mm M.S. angle bracing at 1500mm from joints.

			nuts and bolts.	
1501 to 2250	1.0	20	40x40x5mm angle iron be cross braced diagonally with 10mm dia nuts & bolts at 125 centre.	40x40x3mm M.S. angle bracing at 1200mm from joints or 40x40x3 mm M.S. angle diagonal bracing.
2250 and above	1.25	18	50x50x6mm angle iron frame with 10mm dia nuts & bolts at 125 centre.	50x50x3mm M.S. angle bracing at 1200mm from joints or 50x50x3 mm M.S. angle diagonal bracing.

iii) THICKNESS OF SHEET FOR ROUND DUCTS (FROM ISS: 655):

Diameter of Duct (mm)	Thickness of sheet (mm)	
	G.I. Sheets	Aluminium sheets
150 to 500	0.63	0.80
501 to 750	0.80	0.80
751 to 1000	0.80	1.00
1001 to 1250	1.00	1.50
1251 and above	1.25	1.80

Sheet metal ducts shall be fabricated out of galvanized steel sheets conforming to BIS 655, BIS 277, BIS 737. Sheets used shall be produced by Hot dip process and galvanizing shall be Class VIII.

iv) HANGERS FOR DUCT:

Duct Size (mm)	Spacing (M)	Size of MS angle (mm x mm)	Size of rod dia (mm)
Upto 750	2.4	25 x 3	8
751 to 1500	2.4	40 x 5	10
1501 to 2250	2.4	50 x 5	12
2251 to above	2.4	50 x 5	12

v) FABRICATION:

All ducts irrespective of size shall be fabricated and installed in workman like manner, generally conforming to relevant latest code.

a) Ducts so identified on the drawings shall be acoustically lined with thermal insulation as described in the section `Insulation' and as indicated in schedule of quantities. Duct dimensions shown on drawings are overall sheet metal dimensions inclusive of the acoustic lining, where required and indicated in schedule of quantities.

b) Ducts shall be straight and smooth on the inside with neatly finished joints. All joints shall be made air tight.

c) Changes in dimensions and shape of ducts shall be gradual. Curved elbows, unless otherwise indicated, shall have a centre line radius equal to one and a half times the width of the duct. Air turns shall be installed in all vanes, arranged to permit the air to make the turn without appreciable turbulence. Suitable vanes shall be provided in duct collar to have uniform/ proper air distribution.

d) Ducts shall be fabricated as per details shown on drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles of sample size to keep the ducts true to shape and to prevent bulking, vibration, breathing or oil canning.

e) All sheet metal connections, partitions and plenums required to confine the flow of air to and through 18g GI/16 gauge aluminium, thoroughly stiffened with 25mm x 25mm x 3mm angle iron braces and fitted with all necessary doors as required to give access to all parts of the apparatus. Access Doors shall be not less than 45cm x 45cm in size.

vi) INSTALLATION:

All ducts shall be installed generally as per the drawings and in strict accordance with approved shop drawings to be prepared by the Contractor.

i. The Contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent, of these specifications and drawings. The work shall meet with the approval of Owner's site representative in all its parts and details.

ii. All necessary allowances and provisions shall be made by the Contractor for beams, pipes, or other obstructions in the building, whether or not the same are shown on the drawings. Where necessary to avoid beams or other structural work, plumbing or other pipes, and/ or conduits, the ducts shall be transformed, divided or curved to one side, the required area being maintained, all as per the site requirements.

iii. If a duct cannot be run as shown on the drawings, the contractor shall install the duct between the required points by any path available, in accordance with other services and as per approval of Owners site representatives.

iv. All duct work shall be independently supported from building structure. Duct shall be supported to the ceiling with the help of anchor fasteners by drilling holes in concrete slab and inserting anchor fasteners and bolts. All horizontal ducts shall be rigidly and securely supported, in approved manner with trapeze hangers formed of MS rods and angle iron under ducts at not greater than 2.4-meter centers. All vertical duct work shall be supported

v. by structural members at each floor.
If duct is passing through in such areas where space between ceiling slab to false ceiling is more than 1500 mm than duct should be supported by wall mounted brackets of 40x40x3 mm angle.

Ducting over furred ceiling shall be supported from the slab above, or from beams, after obtaining approval of Owner's site representative. In no case shall any duct by supported from false ceiling hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other contractors on the building.

vi. Where metal ducts or sleeves terminate in wood work, tight joints shall be made by means of closely fitted heavy flanged collars. Where ducts pass through brick or masonry opening and wooden frame work shall be provided within the opening and crossing ducts provided with heavy flanged collars on each side of wooden frame work, so that duct crossing is made leak-proof.

vii. All ducts shall be totally free from vibration under all conditions of operation. Whenever duct work is connected to fans, air handling units or blower coil units that may cause vibrations in the ducts, ducts shall be provided of closely woven, rubber impregnated double layer canvas or neoprene coated fibre glass fire resistant flexible connection. The flexible connections located close to the unit, in mutually perpendicular directions. The flexible sleeve at least 10cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting duct work rigidly held by independent supports on both ends. The flexible connection shall be suitable for pressures at the point of installation and shall be class 'O' smoke rated.

viii. Air conditioning unit and exhaust fans shall be connected to duct work by inserting at air inlet and air outlet a double canvass sleeve. Each sleeve shall minimum 150mm securely bolted to duct and the connecting duct work rigidly held in line with unit inlet or outlet and shall be class 'O' smoke rated.

viii. All ducts above 450 mm are to be cross broken to provide rigidity to the ducts.

2. VOLUME CONTROL DAMPERS

i) At the junction of each branch duct with main duct and split of main duct, splitter dampers must be provided. Dampers shall be two gauges heavier than gauge of the large duct, and shall be rigid in construction to the passage of air.
ii) The volume control dampers shall be of opposed blade type, lever operated and complete with locking devices, which will permit the dampers to be adjusted and locked in any positions. Quantity of volume control dampers for ducts, plenum and grills shall be covered separately in BOQ.
iii) Automatic and manual volume opposed blade dampers shall be complete with frames and bronze bearings as per drawings. Dampers and frames shall be constructed of 1.6 mm steel and blades shall not be over 225 mm wide. The dampers for fresh air inlet shall additionally be provided with fly mesh screen, on the outside, of 0.8 mm thickness with fine mesh specking.
iv) Wherever required for system balancing, provide a volume balancing opposed blade damper with quadrant and thumb Scroll lock. Provide damper rod and damper block with upset screws. Quantity of volume control dampers shall be covered separately in BOQ.
v) After completion of the duct work, dampers are to be adjusted and set to deliver the required amounts of air as specified on the drawings.
vi) A hinged and gasketed access panel shall be provided on duct work at each control device that may be located inside the duct work.

Actuator for Motorized Volume Control Damper:

Electronic actuation shall be provided. The actuator shall be direct coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assembly shall be of a "V" bolt design with associated "V" shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a "V" clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or set screw type fasteners are not acceptable. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable. For power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable. All spring return actuators shall be capable of both clockwise or counterclockwise spring return operation by simply changing the mounting orientation. Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range. An actuator capable of accepting a pulse width modulating control signal and providing full proportional operation of the damper is acceptable. All actuators shall provide a 2 to 10 VDC position feedback signal. All 24 VAC/VDC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 watts for DC applications. Actuators operating on 120 VAC power shall not require more than 10 VA. Actuators operating on 230 VAC power shall not require more than 11 VA. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb torque capacity shall have a manual crank for this purpose. All proportional actuators shall have an external, built-in switch to allow the reversing of direction of rotation. Actuators shall be provided with a conduit fitting and a minimum three-foot electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections. Actuators shall be CE certified as meeting correct safety requirements and recognized industry standards. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 2-year manufacturer's warranty, starting from the date of installation.

3. FIRE DAMPERS

i) Fire dampers shall be provided in all the supply air ducts and return air ducts (where ever provided in the drawings), return air passage in the air-handling unit room and at all floor crossings. Access door will be provided in the duct before each set of fire dampers.

ii) Fire dampers shall be multi blade louvers type. The blade should remain in the air stream in Open position & shall allow maximum free area to reduce pressure drop &noise in the air passage. The blades and frame shall be constructed with minimum 1.6mm thick galvanized sheet &shall be factory fitted in a sleeve made out of 1.6mm galvanized sheet of minimum 400mm long. It shall be complete with locking device, motorized actuator & control panel.

iii) Fire dampers shall be motorized smoke &fire dampers type. It shall be supplied with spring loaded UL(Underwriters Laboratories) stamped motorized link to close fire damper in the event of rise in duct temperature. Fire damper shall also close on receipt of fire alarm signal to cut off air supply instantaneously. An electric limit switch shall also be operated by the

closing of fire damper, which in turn shall switch off power supply to AHU blower motor as well as strip heaters.

iv) Fire dampers shall be CBRI tested &certified for 90 minutes rating against collapse & name penetration as per UL 555-1995(Under writer's laboratories)

v) Fire dampers shall be compatible with the fire detection system of building & shall be capable of operating automatically through an electric motor on receiving signal from fire alarm panel.

vi) Necessary wiring from fire alarm panel up to AHU electric panel shall be provided by the lead contractor& further from AHU electric panel to fire damper shall be provided by sub-contractor.

Actuator for Motorized Fire/Smoke Damper:

Electronic actuation shall be provided with spring return mechanism. The actuator shall be direct coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assembly shall be of a "V" bolt design with associated "V" shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. All actuators shall have a "V" clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or set screw type fasteners are not acceptable. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable. For power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable. All actuators shall be capable of both clockwise and counterclockwise spring return operation by simply changing the mounting orientation. All 24 VAC/VDC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for holding and 30VA for running in AC applications. Actuators operating on 230 VAC power shall not require more than 17 VA for holding and 30VA for running. Spring return actuators with more than 60 in-lb. torque capacity shall have a manual crank for manual position of dampers. All actuators should be form-fit with minimum IP54 degree of protection. Actuators shall be provided with a conduit fitting and a minimum three-foot electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections. Actuators shall be either CE or UL555 certified as meeting correct safety requirements and recognized industry standards. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 2-year manufacturer's warranty, starting from the date of installation. All actuators should be maintenance free.

4. ACCESS PANELS:

A hinged and gasket access panel shall be provided on duct work at each control device that may be located inside the duct work.

5. MISCELLANEOUS:

i) All ducts above 450 mm are to be cross broken to provide rigidity to the ducts.
ii) All duct work joints are to be true right angle or approaching with all sharp edges removed.
iii) Smoke rated sponge rubber gaskets also to be provided behind the flange of all grilles.
iv) Each branch from the duct, leading to a grille, shall be provided with an air deflector to divert the air into the grille through the branch.
v) Inspection doors measuring at least 450 mm x 450 mm are to be provided in each system at an appropriate location, as directed by Project Manager/Engineer-in-charge/Consultants.
vi) Diverting vanes must be provided at the bends exceeding 600 mm and at branches connected into the main duct without a neck.
vii) Proper hangers and supports should be provided to hold the duct rigidly, to keep them straight and to avoid vibrations. Additional supports are to be provided where required for rigidity or as directed by Project Manager/Engineer in charge/Consultants.
viii) The ducts should be routed directly with a minimum of directional change.
ix) The duct work shall be provided with additional supports /hangers, wherever required or as directed by the directed by Project Manager/Engineer in charge/Consultants, at no extra cost.
x) All duct supports, flanges, hangers and damper boxes etc. shall be either zinc coated or given 2 coats of anti-corrosion red oxide paint before installation and one coat of aluminum paint after the erection, at no extra cost.
xi) All angle iron flanges to be welded electrically and holes to be drilled.
xii) All the angle iron flanges to be connected to the GSS ducts by rivets at 100 mm centers.
xiii) All the flanged joints, to have a 3 mm neoprene rubber gasket to the flanges with Adhesive.
xiv) The G.S.S. Ducts should be lapped 6 mm across the flanges.
xv) The ducts should be supported by approved type supports at a distance not exceeding 2.4 meters and at every vertical floor penetration.
xvi) Sheet metal connection pieces, partitions and plenums required shall be constructed of 1.25 (18 gauge) sheet thoroughly stiffened with 25 mm x 25 mm angle iron braces and fitted with access doors.
xvii) Readymade (factory fabricated) flanges shall be used for all ducting.
xviii) All duct joints shall be filled up by silicon.
xix) All duct penetrations in fire rated walls and slabs shall be filled up by fire resistant materials of fire rating not less than fire rating of wall / slab.
xx) All ducts immediately behind the grilles/diffusers etc. are to be given two coats of black paint in matt finish unless noted otherwise.
xxi) Wherever ducts are acoustically lined the duct size shall be increased by the thickness of the duct lining.
xxii) Wherever MVCDs are provided, an access door shall be provided for the maintenance.

6. AIR OUTLET AND INLETS (SUPPLY AND RETURN)

i) All air outlets and intakes shall be made of extruded aluminum sections &shall present a neat appearance and shall be rigid with mechanical joints.

ii) Square and rectangular wall outlets shall have a flanged frame with the outside edges returned or curved 5 to 7 mm and fitted with a suitable flexible gasket between the concealed face of the flanges and the finished wall face. The core of supply air register shall have adjustable front louvers parallel to the longer side to give up to 22.5 degrees vertical deflection and adjustable back louvers parallel to the shorter side to achieve a horizontal spread air pattern to at least 45 degrees. Return air grilles shall have only front louvers. The outer framework of the grilles shall be made of not less than 1.6 mm thick aluminum sheet. The louvers shall be of aero foil design of extruded aluminum section with minimum thickness of 0.8mm at front and shall be made of 0.8mm thick aluminum sheet. Louvers may be spaced 18 mm apart.

iii) Square and rectangular ceiling outlets/intakes shall have a flange flush with the ceiling into which it is fitted or shall be of anti-smudge type. The outlets shall comprise an outer shell with duct collar and removable diffusing assembly. These shall be suitable for discharge in one or more directions as required. The outer shell shall not be less than 1.6 mm thick extruded section aluminum sheet. The diffuser assembly shall not be less than 0.80 mm thick extruded aluminum section.

iv) Circular ceiling outlets/intakes shall have either flush or anti-smudge outer cone as specified in the tender specifications. Flush outer cones shall have the lower edge of the cone not more than 5 mm below the underside of the finished ceiling into which it is fitted. Anti-smudge cones shall have the outer cone profile designed to reduce dirt deposit on the ceiling adjacent to the air outlet. The metal sheet used for construction of these shall be minimum 1.6 mm thick extruded aluminum sheet.

v) Linear diffusers shall have a flanged frame with the outside edges returned 3.5 mm and shall have one to four slots as required. The air quantity through each slot shall be adjustable. The metal sheet used for the construction of these shall be minimum 1.6 mm thick extruded aluminum sheet.

vi) Grilles and diffusers constructed of extruded aluminum sections shall have grille bars set straight, or deflected as required. These shall be assembled by mechanical interlocking of components to prevent distortion. These grilles and diffusers shall have a rear set of adjustable blades, perpendicular to the face blades for deflection purposes.

vii) All supply air outlets shall be fitted with a **VOLUME CONTROL DEVICE**, made of extruded aluminum gate section. The blades of the device shall be mill finish/ block shade pivoted on nylon brushes to avoid rusting & rattling noise, which shall be located immediately behind the outlet and shall be fully adjustable from within the occupied space without removing any access panel. The volume control device for circular cutlets shall be opposed blade radial/shutter type dampers, or two or more butterfly dampers in conjunction with equalizing grid. Opposed blade dampers shall be used for square and rectangular ceiling/ wall outlets and intakes.

viii) All the products supplied by contractor should supplement 'in performance by selection curves of product ratings from the manufacturer.

ix) Laminar supply air diffusers shall be made of 2mm thick powder coated aluminum sheet duly insulated with 5mm thick dosed cell polyethylene foam insulation having factory laminated aluminum foil and joints covered with self-adhesive aluminum tape and having holes 2/3 mm dia. including frame work.

7. FRESH AIR INTAKES

i) Fresh air intake grills/Louvers shall be made of extruded aluminum sections.
ii) A flanged frame using RS sections shall be provided on front face to conceal the gap between the louvers and the adjoining wall face. Corners of frame shall be welded. The frame shall be made structurally rigid.
iii) Louvers made from extruded aluminum section shall be in modular panel form for ease of handling. These shall be free from waves and buckles. Vertical blades shall be truly vertical and horizontal blades shall be truly horizontal. Butt joints in blades shall not be accepted.
iv) Additional intermediate equally spaced supports and stiffeners shall be provided to prevent sagging/vibrating of the louvers, at not more than 750mm centers where the louver's length is longer than 750rnm.
v) A bird wire screen made of 12 mm mesh in 1.6 mm steel wire held in angle or channel frame shall be fixed to the rear face of the louver frame by screens.

8. BACK DRAFT DAMPERS

The dampers shall be installed at the outlet of the unit. The damper should be air-tight and should be in a position to prevent back flow. Dampers shall be opposed blade in 18G and 20G blades in G.I construction. Damper shall be operated manually through lever and constructed with suitable links and levers.

9. TESTING

The entire air distribution system shall be balanced to supply the air quantities as required in various zones and rooms to maintain the specified room conditions. The final balancing of air quantities thorough each air outlet shall be recorded and submitted to Consultant/Client for approval.

All ducts will be pressure tested for leakage. The entire ducting shall be tested for leakage with help of soap solution if required. The Contractor shall arrange, on his own, duct leakage system required for pressure testing of duct.

The ducting work shall be completed with inspected chamber as per US standard for taking out samples and inside duct cleaning shall be provided at required length.

Test and Balance report shall be submitted after proper testing and balancing of the system.

10. INSTALLATION PRACTICE

a) SUPPORT HANGERS:

i. The flexible duct must be installed fully extended to produce optimum results.

ii. The maximum allowable sag, between any two adjacent suspension points, should not exceed 50mm per meter.

iii. The distance between any two adjacent suspension points may vary from 1.50 to 3.00 meter, depending upon the type of flexible duct in use.

iv. Flexible ducts above suspended ceiling should always be independently supported. Ducts mounted in these locations are susceptible to damage whenever ceilings panels need to be periodically interchanged, unless they are separately supported

b) BENDING RADIUS

All bends should be made as large as possible and should have a radius of not less than the diameter of the duct in use. This reduces un-favorable pressure losses and is particularly important for metal-based products which are more susceptible to stress rupturing. Double bends should be avoided, however if un-avoidable, ensure that each radius is not less than R = 2 x D.

c) STRAPS

The hanging straps should support the flexible duct with a minimum of half the circumference surface in contact, and without reducing the effective inside diameter of the duct. It is also recommended that the minimum width of material to be used for the hanging straps should be at least 25mm.

d) FLEXIBLE DUCT TO CONVENTIONAL DUCT CONNECTION

Extra care should be taken when making flexible connection to fix conventional ducts, etc., and ensure that they do not become too stressed. An additional support is recommended to obviate this potential problem.

Metal based flexible duct products are particularly prone to fracturing due to stress caused as a result of sharp connections.

11. STEEL WIRE ROPE HANGERS & SUPPORTS

Wire Hangers shall be used to suspend all static HVAC Air Distribution services.

Wire Hangers should consist of a pre-formed wire rope sling with a range of end fixings to fit various substrates and service fixings, these include a ferruled loop, permanently fixed threaded M6 (or M8, M10) stud, permanently fixed nipple end with toggle, at one end or hook or eyelet, cladding hook, barrel, wedge anchor, eyebolt anchor or any other end fixture type or size as per manufacturers recommendation and design. The end fixings and the wire must be of the same manufacturer with several options available. The system should be secured and tensioned with a Hanger self-locking grip (double channel lock)at the other end. Once the grip is locked for safety purpose unlocking should only be done by using a separate setting key and should not be an integral part of the self-locking grip. Only wire and/or supports supplied and/or approved, shall be used with the system.

a. Wire Hangers should have been independently tested by Lloyds Register. APAVE, TUV, CSA, Chiltern International fire, ADCAS, Intertek, ECA, and SMACNA, approved by CSA and comply with the requirements of DW/144 and BSRIA – wire Rope Suspension systems. Wire rope should be manufactured to BSEN 12385: 2002

b. The contractor shall select the correct specification of wire hanger to use for supporting each particular service from table 1 below. Each size is designated with a maximum safe working load limit (which incorporates a 5:1 safety factor).

The correct specification of wire hanger required is determined using the following formula.

Weight per meter of object suspended (kg) X distance between suspension points (m) = weight loading per Hanger suspension point (kg).

Where the installed wire rope is not vertical then the working load limit shall be reduced in accordance with the recommendations give in the manufacturer's handbook.

The contractor shall select the correct length of wire rope required to support the service. Specials can be made, check with manufacturer. No in–line joints should be made in the rope.

The standard range of Hanger Kits should contain galvanized high tensile steel wire rope or stainless-steel wire rope as per the application, the minimum specification is as above and should be manufactured to BS 302 (1987), BSEN12385. Comply with manufacturer's load ratings and recommended installation procedures. Note the testing is done to the minimum breaking load of the wire thus giving a minimum safety factor of 5: 1.

12. **HVAC Supports – Hanger Supports are suitable for: Rectangular duct, Spiral Duct, Oval Duct, Fabric Duct, Desertification fans, Air Conditioning Units, Plenum Boxes, Fan Coil Units, Grilles and Diffusers.**

Ducting Supports:
All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with hangers formed of galvanized steel wire ropes and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel wire hangers under ducts, rigid supports may be provided at certain interval if need be. The spacing between supports should be not greater than 2.4 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates or Toggle end wire fixing left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the wire rope hanger shall be welded to the plates. Trapeze hanger formed of galvanized steel wire rope shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Wire rope supports shall hang through the cleats or wire rope threaded studs can be screwed into the anchor fasteners. In case of PEB structure Loop and Catenary system can be used based on the site conditions as per approved suspension system drawings.

All horizontal ducts shall be adequately secured and supported. In an approved manner, with trapeze Hangers formed of galvanized steel wire rope in a cradle support method (refer to typical drawings) under ducts at no greater than 3000mmcentre, for 3001mm-above appropriate size angle along with neoprene pad in between the duct & MS angle should be used with prior approval. All vertical duct work shall be supported by structural members on each floor slab. Duct support shall be through dash / anchor fastener driven into the concrete slab by electrically operated gun. Hanger wires shall then hang around the ducting. Rigid supports shall be used in conjunction with wire rope hangers to assist with alignment of services where recommended for by the manufacturer. Rigid support must also be used in conjunction with wire rope hangers with duct work at each change of direction or connectionor as per approved drawings. Support ducting in accordance with Schedule I at the end of this Section. In cases of

Spiral ducting the wire can be wrapped directly around the ducting without the need for a spiral ducting clamp for sizes above 1100 a cradle support should be provided, refer to manufacturer's recommendations.

Ducting over furred ceiling shall be supported from the slab above or from beams after obtaining approval of Construction manager/consultant. In no case shall any duct be supported from false ceiling Hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other Contractor's work in the building. All supports of pipe shall be taken from structural slab/wall by means of fastener.

13. MEASUREMENT FOR DUCTING AND GRILLES/DIFFUSERS

Unless otherwise specified, measurements for ducting for the project shall be on the basis of centre-line measurements described herewith:

i) Duct Work shall be measured on the basis of external surface area of ducts. Duct measurements shall be taken before application of the insulation. The external surface area shall be calculated by measuring the perimeter comprising overall width and depth, including the corner joints, in the centre of each duct section, multiplying with the overall length from flange face to flange face of each duct section and adding up areas of all duct sections. Plenums shall also be measured in similar manner.

ii) For tapered rectangular ducts, the average width and depth shall be considered for perimeter, whereas for tapered circular ducts, the diameter of the section midway between large and small diameter shall be adopted, the length of tapered duct section shall be the centre line distance between the flanges of the duct section.

iii) For special pieces like bends, tees, reducers, branches and collars, mode of measurement shall be identical to that described above using the length along the centre line.

iv) The quoted unit rate for external surface of ducts shall include all wastage allowances, flanges and gaskets for joints, nuts and bolts, hangers and angles with double nuts for supports, rubber strip 3 mm thick between duct and support, vibration isolator suspension where specified or required, inspection chamber / access panel, splitter damper with quadrant and lever for position indication, turning vanes, straightening vanes, and all other accessories required to complete the duct installation as per the Specifications. These accessories shall NOT be separately measured nor paid for.

Special Items for Air Distribution shall be measured by the cross-section area perpendicular to air flow, as identified herewith:

a) Grilles and registers - width multiplied by height, excluding flanges. Volume control dampers shall form part of the unit rate for registers and shall not be separately accounted.

b) Diffusers - cross section area for air flow at discharge area excluding flanges. Volume control dampers shall form part of unit rate for supply air diffusers and shall not be separately accounted.

c) Linear diffusers - shall be measured by cross-sectional areas and shall exclude flanges for mounting of linear diffusers. The supply air plenum for linear diffusers shall be measured with ducting as described earlier.

d) Flexible connection - shall be measured by their cross-sectional area perpendicular to the direction of air flow.

e) Fire Damper-shall be measured by their cross-sectional area perpendicular to the direction of air flow and actuators shall be on counting basis.

PART VII- MECHANICAL VENTILATION SYSTEM

1. SCOPE

This chapter includes supply air fans, exhaust air fans and fans used in any equipment like AHUs, FCUs etc.

2. AXIAL FLOW FANS:

i) Fan shall be complete with motor, motor mount, belt driven (or direct driven) and vibration isolation type, suspension arrangement as per approved for construction shop drawings.

ii) Casing shall be constructed of heavy gauge sheet steel. Casing shall be provided with hinged door enabling easy replacement of wheel, shaft and bearings. A small inspection door with handle and neoprene gasket shall also be provided. Casing shall have flanged connection on both ends for ducted applications. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts.
Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be de-rusted, cleaned, primed and finish coated with enamel paint.

iii) Rotor hub and blades shall be of cast aluminum, or cast steel construction. Blades shall be die-formed aero foil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. Fan blade mounting on the hub shall be statically and dynamically balanced. Extended grease leads for external lubrication shall be provided. The fan pitch control may be manually read just able at site, upon installation, for obtaining actual airflow values, as specified.

iv) Motor shall be of 3 phase squirrel-cage totally enclosed; fan cooled type. Motor and starter shall be in accordance with Part VIII Para 1.9 respectively. The speed of fan shall not exceed 1000 RPM for fans with impeller diameter above 450mm, and 1450RPM for fans with impeller diameter of 450mm and less. The fan motor shall have efficiency class IE-2.

v) **Vibration Isolation**
Base shall be provided for each fan. Base for both fan and motor shall be built as an integral part and shall be mounted on a concrete foundation through cushy foot vibration isolators. The concrete foundations shall be at least 15 cm above the finished floor level and shall be further isolated from the structural floor through 5 cm. Thick layers of sand all around, topped with bitumen. In case ceiling hung fan within the ceiling shall be provided Vibration Isolation Suspension (VIS) shall be provided in each of string.

Types of Vibration Isolators:

i) **Free Spring Floor Mounted Isolators**

Vibration isolators shall be free standing, un-housed, laterally stable springs wound from high strength spring steel. Springs shall have a lateral stiffness greater than 0.8 times the rated vertical stiffness and shall be designed to provide up to 50% overload capacity. Springs shall be supported either with a neoprene cup or a metal base plate complete with a ribbed neoprene pad, minimum 6 mm (0.25") thick, bonded to the base plate. Springs shall be selected to provide operating static deflections as required. Springs shall be color coded or otherwise identified to indicate load capacity. In capacities up to 5,000 lbs., springs shall be replaceable. In capacities over 5,000 lbs., springs shall be welded to the top and bottom load plate assemblies. Springs shall be assembled between a top and bottom steel load plate. The upper load plate shall be provided with a steel leveling bolt lock nut and washer for attachment to the supported equipment.

ii) **Restrained Spring Floor Mounted Isolators**

Vibration isolators for equipment which is subject to load variations and large external or torquing forces shall consist of large diameter laterally stable steel springs assembled into formed or welded steel housing assemblies designed to limit vertical movement of the supported equipment. Springs shall be supported either with a neoprene cup of a metal base plate complete with a ribbed neoprene pad, minimum 6 mm (0.25”) thick, bonded to the base plate. Housing assembly shall be formed or fabricated steel members and shall consist of a top-load plate complete with adjusting and leveling bolts, vertical restraints, isolation washers and a bottom plate with non-skid noise stop pads and holes provided for anchoring to supporting structure. Housing shall be hot dipped galvanized.

iii) **Vibration Modular Restrained Spring Isolator**

Spring isolators shall be comprised of two interfacing but independent elements; a coil spring element and a seismically rated housing. The spring coil element shall be comprised of one or more coil assemblies having all of the characteristics of freestanding coil spring isolators as specified in the vibration isolation portion of the specification. The seismically rated housing shall be sized to meet or exceed the force requirements applicable to the project and have the capability of accepting coils of various sizes, capacities, and deflections as required to meet the desired isolation criteria. All spring forces will be contained within the coil/housing assembly and under no seismic load condition shall the restraint anchoring hardware be exposed to spring - generated forces. The restraint element shall incorporate a steel housing with elastomeric elements at all dynamic contact points. The restraint will allow a maximum of 1/4 in. (25 mm) motion in any direction from the neutral position. All elastomeric elements shall be replaceable. To ensure the optimum anchorage capacity, the restraint will have an overturning factor (the ratio of the effective lateral snubber height to the short axis anchor spacing) of 0.33 or less.

iv) **Vibration/Seismic Modular Restrained Spring Isolator**

Vibration isolators shall be seismically rated, restrained spring isolators for equipment which is subject to load variations and large external forces. Spring isolators shall be comprised of two interfacing but independent elements; a coil spring element and a seismically rated housing. The spring coil element shall be comprised of two or more coil assemblies having all of the characteristics of freestanding coil spring isolators as specified in the vibration isolation portion of the specification. The seismically rated housing shall be sized to meet or exceed the force requirements applicable to the project and have the capability of accepting coils of various sizes, capacities, and deflections as required to meet the desired isolation criteria. The housing shall be hot dipped galvanized for corrosion resistance. All spring forces will be contained within the coil / housing assembly and under no seismic load condition shall the restraint

anchoring hardware be exposed to spring generated forces. The single restraint element shall incorporate a steel housing with elastomeric elements at all dynamic contact points. The single restraint will allow 1/4 in. (25mm) motion in any direction from the neutral position. All elastomeric elements shall be replaceable in the field after an event without lifting the unit.

3. PROPELLER FAN

i) Propeller fan shall be direct-driven, three or four blade type, mounted on a steel mounting plate with orifice ring.

ii) Mounting Plate shall be of steel construction, square with streamlined venturi inlet (reversed for supply applications) coated with baked enamel paint. Mounting plate shall be of standard size, constructed of 12-to-16-gauge sheet steel depending upon the fan size. Orifice ring shall be correctly formed by spinning or stamping to provide easy passage of air without turbulence and to direct the air stream.

iii) Fan Blades shall be constructed of aluminum or steel. Fan hub shall be of heavy welded steel construction with blades bolted to the hub. Fan blades and hub assembly shall be statically and dynamically balanced at the manufacturer's works.

iv) Shaft shall be of steel, accurately ground and shall be of ample size for the load transmitted and shall not pass through first critical speed thru the full range of specified fan speeds.

v) Motor shall be standard (easily replaceable) permanent split capacitor or shaded pole for small sizes, totally enclosed with pre-lubricated sleeve or ball bearings, designed for quiet operation with a maximum speed of 1000 rpm for fans 60 cm dia or larger and 1440 rpm for fans 45 cm dia and smaller. Motors for larger fans shall be suitable for 415±6% volts, 50 cycle's 3 phase power supply, and for smaller fans shall be suitable for 220±6% volts, 50 cycle's single phase power supply. Motors shall be suitable for either horizontal or vertical service as indicated on drawings and system design requirements. The motor shall be rated for IP-55.

vi) Accessories:
The following accessories shall be provided with propeller fans:

a) Wire guard on inlet side and bird screen at the outlet.
b) Fixed or gravity louvers built into an aluminum steel frame at the outlet.
c) Electronic speed controller for controlling fan speed for single phase fan motor and variable speed drives for three phase motors.
d) Single phase preventers for 3 phase fans.

4. INLINE FANS

i) SCOPE
The scope of comprises of supply, erection, testing and commissioning of inline fans conforming to these specifications and in accordance with the Schedule of Quantities and drawings.

ii) TYPE
Fans shall be single inlet single width (SISW) type / Double Inlet Double Width (DIDW). Fan shall have directly driven forward curved centrifugal impeller, running in a metal scroll balanced to give quiet and vibration free operation. Fan motor assembly shall be statically and dynamically balanced.

The fan shall be assembled in such a manner that the motor and impeller can be easily

removed and reinstalled after servicing.
The air handling capacities, maximum motor H.P., Static pressure shall be as shown on Drawing and in Schedule of Quantities.

iii) MATERIAL
   a) Fans casing shall be manufactured from galvanized steel sheets.
   b) All other metal parts shall be hot dip galvanized.

iv) MOTOR
   a) The fan motor shall be equipped with motor with speed regulator giving volume control from 0 to 100% of output.
   b) Motors shall be with class 'F' insulation wired to an externally mounted weather proofed terminal box.
   c) Motor name plate horsepower shall exceed brake horsepower by minimum of 10%. Motor shall be designed especially for quiet operation and motor speed shall not exceed 1500 RPM.

v) INSTALLATION
   a) Fan shall have rigid supports and fitted to both ends of the casing.
   b) Wherever the fans are to be suspended from ceiling or mounted on the wall, the contractor shall include supply and fixing of all the material that may be required to complete the installation in all respect.
   c) Fan inlet and outlet connections shall be by means of flexible canvas connections.

vi) TESTING

Fan after installation shall be tested for capacities, power consumption, noise level and vibration and results shall confirm to the approved data furnished by the contractor.

vii) ELECTRIC POWER CONSUMPTION
Single phase, 220 V, 50 Hz power supply point within 2 meters from the fan shall be available. All further wiring shall be in the scope of the HVAC contractor.

PAINTING
All equipment shall be supplied with the manufacturer's standard finished painting.

PART VIII–REFRIGERANT PIPING WORK

1. SCOPE
This chapter covers the requirements of plumbing work in **Refrigerant Piping, Normal water and drains**, to be executed as part of heating, ventilating and air conditioning.

2. PIPING DESIGN
Pipe sizes shown in tender documents are purely for sub-contractor's guidance. The sub-contractor shall be responsible for selection of sizes as per detailed engineering to be done by him. Piping design to be done by the Air-conditioning contractor shall conform that
Plumbing drawings showing the sizes of valves, layout and other details shall be prepared and shall be got approved from the Engineer-in-Charge before the execution of the plumbing Work.

3. REFRIGERANT PIPING

DESIGN ASPECTS OF REFRIGERANT PIPING

Refrigerant piping shall be designed and installed so as to:

i) Ensure circulation of adequate refrigerant at all loads.
ii) Ensure oil return to crank case of compressor positively and continuously.
iii) Keep pressure losses within limits, especially in suction lines.
iv) Prevent oil/liquid refrigerant from entering the compressor when the compressor is working as well as when it has stopped.
v) Prevent trapping of oil in evaporator or suction lines, which may return to the compressor in the form of slug.
vi) The refrigeration system shall be equipped with controls for pump down system so that the evaporator and suction line are emptied before the compressor shuts off, thus preventing liquid refrigerant and oil from entering the compressor when restarted.
vii) Refrigerant lines shall be sized to limit pressure drop between evaporator and condensing unit to less than 0.2 kg. Per sq.cm. (3 psi).

4. Copper Piping:

Seamless soft copper tubing, type L shall be used to make connections to equipment, wherever required or specified.

Flare fittings e.g. flare nuts, tees, elbows, reducers etc. shall all be of brass.

5. Refrigerant Piping:

All refrigerant piping for the air conditioning system shall be constructed from soft seamless up to 19.1mm and hard drawn copper refrigerant pipes for above 19.1mm with copper fittings and silver-soldered joints. The refrigerant piping arrangements shall be in accordance with good practice within the air conditioning industry, and are to include charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits.

All joints in copper piping shall be sweat joints using low temperature brazing and or silver solder. Before joining any copper pipe or fittings, its interiors shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently, it shall be thoroughly blown out using nitrogen.

After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using nitrogen at pressure of 20Kg per sq.cm and 10 Kg per sq.cm (low side). Pressure shall be maintained in the system for 24 hours. The system shall then be evacuated to minimum vacuum if 700mm hg and held for 24 hours.

The air-conditioning system supplier shall be design sizes and erect proper interconnections of the complete refrigerant circuit.

	Pipe Size in mm(OD)	**Wall Thickness in mm**
a)	41.3	1.4
b)	38.1	1.3
c)	34.9	1.2
d)	31.8	1.1

e)	28.6	1.0
f)	25.4	1.0
g)	22.2	1.0
h)	19.1	1.0
i)	15.9	1.0
j)	12.7	0.8
k)	9.5	0.8
l)	6.4	0.8

The suction line pipe size and the liquid line pipe size shall be selected according to the manufacturers specified outside diameter. All refrigerant pipes shall be properly supported and anchored to the building structure using steel hangers, anchors, brackets and supports which shall be fixed to the building structure by means of inserts or expansion shields of adequate size and number to support the load imposed thereon.

6. VRV INDOOR UNIT DRAIN PIPING:

Condensate from the Indoor unit shall be drained through properly installed drain piping designed to prevent any accumulation of condensate in the drain pan. Drain piping shall be made of rigid PVC pipe of 6 Kg/cm sq. pressure rating with water tight threaded connections. Leading from the Indoor unit to a suitable drain point as per the drawings. Complete drain piping shall be made leak proof and water tight by means of precise installation and the use of leak proof sealant / adhesives.

7. AHU CONDENSATE DRAIN PIPING:

All pipes to be used for condensate drain for AHUs/AIR WASHER shall be insulated with 13 mm thick Nitrile rubber insulation "B" class GI pipe & all joints should be Gluing or solvent cementing as per manufacturer recommendation.

8. DX TYPE UNIT DRAIN PIPING:

Condensate from the Indoor unit shall be drained through properly installed drain piping designed to prevent any accumulation of condensate in the drain pan. Drain piping shall be made of rigid PVC pipe of 6 Kg/cm sq. pressure rating with water tight threaded connections. Leading from the Indoor unit to a suitable drain point as per the drawings. Complete drain piping shall be made leak proof and water tight by means of precise installation and the use of leak proof sealant / adhesives.

Drain lines shall be provided at all the lowest points in the system, as well as at equipment, where leakage of water is likely to occur, or to remove condensate and water from pump glands.

9. PIPE INSULATION

a. Refrigerant Pipe Insulation

The whole of the liquid and suction refrigerant lines including all fittings, valves etc. shall be insulated with 19mm /13 mm thick XLPE insulation or as specified in BOQ.

b. Drain Pipe Insulation

Drain pipes carrying condensate water shall be insulated with 6 mm thick elastomeric nitrile rubber insulation. For proper drainage of condensate, U Trap shall be provided in the drain

piping (wherever required). All pipe supports shall be of pre-fabricated & pre painted slotted angle supports, properly installed with clamps etc.

10. BALANCING

i) After completion of the installation, all system shall be adjusted and balanced to deliver the refrigerant quantities as specified and required to meet the cooling in each space.
ii) Testing and Balance report shall be submitted in coordination with the design documents.

11. MEASUREMENTS OF PIPING, FITTINGS, VALVES, FABRICATED ITEMS:

1. PIPES:
Including refrigerant piping, drain piping and all other piping required to be executed at site for completion of the work:

i) All pipes shall be measured in linear meter (to the nearest cm) along the axis of the pipes and rates shall be inclusive of all fittings and branches e.g. tees, bends, reducers, elbows etc. deduction shall be made for valves in the line.

ii) Exposing reinforcement in wall and ceiling and floors of possible and making good the same or installing anchor fasteners and inclusive of all items as specified in specifications and Schedule of Quantities.

iii) Rates quoted shall be inclusive of providing and fixing vibration pads and wooden pieces, wherever specified or required by Project Coordinator.

iv) Flexible connections, wherever required or specified shall be measured as part of straight length of same diameter, with no additional allowance being made for providing the same.
v) The length of the pipe for the purpose of payment will be taken through the centerline of the pipe and all fittings (e.g. tees, bends, reducers, elbows, etc.) as through the fittings are also presumed to be pipe lengths. Nothing extra whatsoever will be paid for over and above for the fittings for valves and flanges.

2. STRUCTURAL SUPPORTS
Structural supports including supports fabricated from pipe lengths for pipes shall be measured as part of pipe line and hence no separate payment will be made. Rates shall be inclusive of hoisting, cutting, jointing, welding, cutting of holes and chases in walls, slabs or floors, painting supports and other items as described in specifications, drawings and schedule of quantities or as required at site by Project Coordinator.

12. EXPANSION OR CONTRACTION:

The contractor shall provide for expansion and contraction of all piping installed by the use of swing connections and expansion loops.

13. ARRANGEMENT AND ALIGNMENT OF PIPING (To be coordinated with other Trades):

i) All piping shall be arranged and aligned in accordance with the drawings as specified. Where special conditions are encountered in the field, the arrangement and alignment of piping shall be as directed by the Project Manager/Engineer-in-charge/Consultants.

ii) The piping shall be installed in a uniform manner, parallel to or perpendicular to walls or ceilings, and all changes in directions shall be made with fittings. The horizontal piping shall be run at right angles and shall not run diagonally across rooms or other piping. Wherever possible all piping shall be arranged to provide maximum head room.

iii) All piping shall be installed as directly as possible between connecting points in so far as the work of other trades permits. Where interference occurs with another trade whose work is more difficult to route, this contractor shall reroute his pipes as required to avoid interference, at the discretion of the Project Manager/Engineer-in-charge/ Consultants.

iv) All piping shall be carefully installed to provide for proper alignment, slope and expansion.

v) The stresses in pipe lines shall be guided and pipes shall be supported in such a manner that pipe lines shall not creep, sag or buckle.

vi) The piping shall be grouped wherever practical and shall be installed uniformly in straight parallel lines in either vertical or horizontal positions.

PART IX- INSULATION WORK

1. SCOPE

This chapter covers the requirements of thermal insulation for duct work, Refrigerant piping and acoustic lining in duct work and weather maker rooms. This does not cover exposed roof insulation and under deck insulation work.

2. MATERIAL TYPES

i) For Insulation of duct work Thermal insulation material for Duct insulation shall be anti-microbial closed cell cross linked polyethylene foam. Thermal conductivity of the insulation material shall not exceed 0.032 W/mK at an average temperature of 25C. Density of the material shall be 25-30 Kg/m3. The product shall have temperature range of –40C to 105C.

The insulation material shall be fire rated for Class 1 as per BS 476 Part 7, 1987 for surface spread of flame test. Water vapor permeability as per DIN 52615 shall not exceed 0.15ng/Pa.Sec.m.

Thermal conductivity of the material shall not be affected by ageing, as per DIN 52616. The material must be tested for ageing effect in an accredited laboratory for a minimum period of five years to satisfy the ageing criteria.

The smoke density of the material as per AS-1530.3 shall not exceed 1. There shall be no toxicity in the emitted smoke, both under flaming and non-flaming conditions, as per AITM 3.000 (1993).

3. APPLICATION OF INSULATION (THERMAL) ON DUCT

i) Surface of duct on which the thermal insulation is to be provided shall be thoroughly cleaned with wire brush and rendered free from all dust and grease.

ii) Additional treatment on Exposed duct insulation which is exposed to the outer atmosphere
   a. Apply tack coat of insulation protective coating Starbond(SB 30-36) evenly by brush @ 2 to 2.5 m^2/liter (Min 0.4mm thick)
   b. After applying tack coat embed the glass fiber or canvas cloth immediately and make it wrinkle free.
   c. Apply first coat of Starbond (SB 30-36) on prepared surface evenly @ 2.5 to 3 m^2/liter (Min. 0.4 mm thick).
   d. Apply finish coat of Starbond(SB 30-36) @ 2.5 to 3 m^2/liter (Min. 0.4 mm thick) once first coat is fully cured.

4. APPLICATION OF DUCT LINING (ACOUSTIC INSULATION)

Where specified in the tender specifications, ducts shall be lined internally with acoustic insulation as detailed below:

i) The Inside surface of duct on which the acoustic lining is to be provided shall be thoroughly cleaned with wire brush and rendered free from all dust and grease.

ii) Then 25 x 25 sq.mm section of minimum 1.25 mm thick G.I. sheet shall be fixed on both ends of the duct piece.

iii) The insulation slabs shall then be fixed between these sections of ducts using CPRX adhesive compound and stickpins.

iv) The insulation shall then be covered with Reinforced plastic/ fiber glass tissue, sealing all joints so that no fiber is visible.

v) The insulation shall finally be covered with minimum 0.5 mm thick perforated aluminum sheet having perforations between 20-40%.

5. APPLICATION OF ACOUSTIC LINING ON AHU TRAP DOORS

i) The door surface should be thoroughly cleaned with wire brush.

ii) A 610 x 610 mm frame work or as required on site of 25mm x 5 0mm x 50mm x 50mm x 25mm shape channel made of 0.6mm thick G.S.S. shall be fixed to the door using adhesives of suitable material.

iii) Resin bonded glass wool/ mineral wool as specified cut to size will be friction fitted in the frame work and covered with tissue paper.

6. MEASUREMENT OF INSULATION

The measurement for vessels, piping and ducts shall be made over the bare un-insulated surface area of the metal.

i) PIPES AND DUCTS:
   The measurements for insulation of piping shall be made in linear meters through all valves, flanges, and fittings. Pipes/bends shall be measured along the centerline radius between tangent points. If the outer radius is R1 and the inner radius is R2 the center line radius shall be measured as (R1+R2)/2. Measurement of all valves, flanges and fittings shall be measured with the running meter of pipe line as if they are also pipe length. Nothing extra

over the above shall be payable for insulation over valves, flanges and fittings in pipe line/routings. Fittings that connect two or more different sizes of pipe shall be measured.

ii) DUCT:
Measurements for insulation of ducts shall be made in actual net square meters of bare un-insulated duct surface through all dampers, flanges and fittings. In case of bends the area shall be worked out by taking an average of inner and outer lengths of the bends. Measurements for the dampers, flanges, fittings shall be for the surface dimension for the connecting duct, nothing extra over the above shall be payable for insulation over dampers, flanges and fittings in duct routing.

iii) ACCESSORIES INSULATION

The unit of measurement for accessories such as expansion tank, pumps etc. shall be un-insulated area in square meters. In case of curved or irregular surfaces, measurements shall be taken along the curves.
The unit insulation price shall include all necessary adhesives, vapor proofing and finishing materials as well as additional labor and material required for fixing the insulation.

iv) ACOUSTIC DUCT LINING

In case of acoustic lining of air ducts, measurements of the bare inside duct surface in square meters shall be final for billing purposes. The insulation/acoustic panels shall include cost of battens, supports, adhesives, vapor proofing, finished tiles/boards/sheets as well as additional labor and materials required for completing the work.

PART X- INSPECTION, TESTING AND COMMISSIONING

1. SCOPE

This chapter covers initial inspection and testing of All major equipment's such as VRV/VRF, Air handling units, panels, fans shall be got inspected by the engineer in charge / customer at works by the AC contractor, if he so desires. All routine and Type tests shall be carried out and the test reports shall be submitted for approval before dispatch. The engineer in charge is free to witness any or all tests. In any case the OEM test certificates shall be submitted to the engineer in charge for verification of the same before the payments for the same can be processed. The AC contractor shall inform the engineer in charge well in time about the date of readiness of the equipment for inspection and testing.

2. INITIAL INSPECTION AT MANUFACTURER'S WORKS (IF REQUIRED)

a. AIR HANDLING UNITS/AIR WAHSERS/SCRUBBERS:

i) Salient features such as model, size, physical dimensions, and other details of various sections, fan motor details, fan dia, static pressure etc. shall be verified against the contract requirements.
ii) Manufacturer's internal test certificates for the motor and air handling unit shall be furnished and scrutinized as per contract requirements.
iii) Test certificate for static and dynamic balancing of the fan/ blower should be furnished. Fan balancing may be witnessed by Engineer-in-Charge or his authorized representative.

iv) Salient features like type, material, no. and gauge of fins and tubes and no. of rows of cooling coil shall be furnished and verified with reference to contract requirements during stage inspection.
v) Hydraulic pressure to the extent of 10 Kgf/sq.cm or pneumatic pressure of 21kgf/ sq.cm shall be applied to cooling coil and this pressure should be maintained for 1 hour and no drop should be observed indicating any leaks.

3. VRV/VRF UNITS, FANS, INDOOR UNITS

i. Salient features such as model and make shall be checked as per the contract requirement and shall be related with name plate/performance curves.
ii. The manufacturer's test certificate shall be furnished and verified.
iii. The test certificates shall be correlated with the equipment serial no.

4. Electric Motor

The motor shall be of approved make. The OEM's test certificates shall be furnished and verified with the name plate and serial no. The requirement shall be as per technical dat submitted.

5. Pipes

Make, wall thickness for the pipe shall be checked at random for 5% of pipe lengths and shall be correlated with relevant codes.

6. Ducting

The GI sheet to be used shall be physically checked for gauge. The bend test shall be performed at site. Randomly one sample of each gauge shall be checked chemically for composition and galvanizing by a reputed lab and report shall be submitted before starting work at site.

7. Insulation

i. All type of insulation material shall be physically checked for quality, thickness as per tender specification.
ii. The samples shall be checked for density at site. The same shall be correlated with the OEM test certificates.
iii. The material shall be having required thermal conductivity which will be verified from TC.

8. INITIAL INSPECTION AT SITE

FOR ASSOCIATED WORKS AT SITE:

i) Inspection of raw materials to be used for fabrication and assembly and inspection of Manufacturer's Certificates.

ii) Inspection of welding including welders qualification as desired by inspection Engineers. Inspection of fabricated items.

iii) Pressure testing of pipe fittings used for the refrigerant and water services.

iv) Pressure testing, leak testing of complete piping network for chilled water and condenser water.

v) Vacuum missing and gas/oil charging for refrigeration system.

vi) Checking of electrical circuits (power & controls) and checking functioning of controls of refrigerant systems and other circuits of air conditioning plant.

vii) Checking of calibration of controls and instrumentation

viii) Performances testing of complete

ix) The above inspection procedure is given for general guidance and information of vendors and inspection of Purchaser/Consultant is strictly not limited to these and Inspection Engineer of Purchaser/Consultant will have full right to have detailed inspection at any stage right from placement of order to completion of project as desired by Inspection Engineer, Co-ordination of Inspection Agency of Purchaser/Consultant with his Factory/Sub-vendor's Factory/Erection Site will be the sole responsibility of successful vendor after placement of order for complete

9. Final Inspection

After completion of entire installation as per specifications in all respects, the AC contractor shall demonstrate trouble free operation of the entire installation simultaneously. The test readings shall be recorded in a mutually acceptable format. All tests shall be carried out by the AC contractor at his own expenses. However necessary utilities such as power and water shall be provided by the owner free of cost.

The tests shall include but will not be limited to the following:

i. To check satisfactory functioning of all equipment installed
ii. Clean all equipment to remove foreign material and construction dirt and dust with Vacuum cleaner.
iii. Verify that the equipment is secure on mounting and supporting devices and that connection for piping, ductwork and electrical are complete.
iv. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
v. Perform cleaning and adjusting specified as per OEM.
vi. Check proper motor `rotation direction and verify fan wheel / pump free rotation and smooth bearing operations.
vii. Reconnect drive system and align belts.
viii. Lubricate bearings, pulleys, belts, and other moving parts with factory recommended lubricants.
ix. Set outside-air / supply air dampers to minimum outside-air setting.
x. Install temporary throw away filters for initial run and finally install clean filters.
xi. Verify manual and automatic volume control, and fire dampers in connected ductwork system are in the full-open position.
xii. Replace fan and motor pulleys as required to achieve design conditions.
xiii. Measure and record motor electrical values for voltage and amperage.

xiv. Shut unit down and reconnect automatic temperature control operators.

xv. Cooling / heating capacity of various Indoor units shall be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Flow measurements shall be by a calibrated rotating vane anemometer and temperature measurements by accurately calibrated mercury-in-glass thermometers. Computed ratings shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current, whereas, noise level at various locations within the conditioned spaces shall be measured by a sound pressure level meter.

NOTE:

i. All measuring instruments such as thermometer, Psychrometers, Pressure gauges, anemometers, Flowmeter, dB Meter, Tong tester, etc. or any other necessary instrument shall be arranged by the AC contractor at his own expense.

ii. The instruments shall be new and shall have a valid calibration certificate from a renowned test lab.

iii. The plant shall be run initially and all equipment's shall be adjusted to give desired results as per contract. Thereafter the plant shall be test run for 96 hours as described above and the readings shall be demonstrated in the required format. The test shall be witnessed by the owners and engineer in charges representative. In case the conditions are not achieved during the initial run test the plant shall be readjusted and the new dates for tests shall be determined. The entire test shall be repeated and satisfactory results shall have to be obtained. Only after satisfactory test the installation shall be taken over by the customer and warranty period for one year shall commence.

iv. The test readings shall be suitably adjusted for the absence of Peak ambient conditions, fouling factor, and available load.

v. The snag list prepared jointly after initial test shall be attended to by the vendor during a maximum of 30 days from the start of warranty period. Failure to do so shall result in corresponding increase of warranty period.

10. TESTING REQUIREMENTS AND PROCEDURES

Balancing of all air and refrigerant systems and all tests as called for in the specification shall be earned out by the HVAC contractor in accordance with the specifications and relevant local codes if any. Performance tests of individual equipment and control shall be carried out as per manufacturer's recommendation. All tests and balancing shall be carried out in the presence of Engineer-in-charge or his authorized representative.

The whole system balancing shall be tested with microprocessor based hi-tech instruments with an accuracy ±. 0.5%. The instrument shall be capable of storing data and then down loading into a P.C. The HVAC contractor shall provide a minimum but not limited to the following instruments:

a) Microprocessor based calculation meter to measure DB and WB temperature, RH and Dew point
b) Velocity meter to measure air volume and air velocity
c) Pitot tube -Electronic rotary vane Anemometer
d) Accubalance flow measuring hood

The contractor shall be responsible to provide necessary sockets and connections for fixing of the testing instruments, probes etc.

11. AIR SYSTEMS

Systems are to be balanced by first adjusting the total flow at the fan, then by adjusting main dampers and branch dampers. Only final minor adjustments are to be made with register and diffuser dampers. Balancing of the air system shall be accomplished without causing objectionable air noise. Baffles and orifice plates required for proper air balance shall be furnished and installed by the contractor. Basically the following tests and adjustments are required.

i) Test and balance all fan systems to provide proper cfm/ cmh.
ii) Adjust fresh air return air and exhaust dampers to provide proper air quantities in all modes of control.
iii) Test and record fresh air, return air and mixed air temperature at all air handling units. Test and record data at all coils after air and hydronic systems are balanced. Measure wet and dry bulb temperature on cooling coils.
iv) Make point tube transverse at all main supply and return ducts to set proper air quantities. Adjust all zone and branch dampers to proper cfm/cmh.
v) Test and adjust each register, grills, diffuser or other terminals equipment to within 5% of design air quantity. Each opening shall be defined on the test report by size manufacturer's model, room location, design cfm and actual cfm. Outlets shall be adjusted to minimize objectionable drafts.
vi) Test and record static pressure drop across all filters and major coils.
vii) High velocity duct systems shall be tested for leakages. If excessive or audible leakage is detected, the defect shall be repaired by the contractor. Sufficient static pressure readings shall be taken from the air handling units to the terminal units to establish system static pressure.
viii) Test and balance VAV boxes per design document to meet minimum and maximum airflows.

12. REFRIGERATION SYSTEM

Systems are to be balanced by opening all valves, closing all by-pass and setting all mixing valves to full coil flow. Water systems shall be cleared of Verify that the system has been properly cleaned, flushed and treated before testing. Basically, the following tests and adjustments are required.

Balancing Tolerance: Systems shall be balanced within the following tolerances

1. Duct leakage Rates (at operating pressures)

Low pressure ducts (0 to 0.5kPa)	5% of full flow
Medium Pressure Ducts (0.5 to 3kPa)	1% of full flow
High Pressure Ducts (Greater than 3kPa)	1% of full flow

2. Air flow rates

Under 70 L/S	10% of flow
Over/ at 70 L/S	5% of flow

Procedure:

i) Review all pertinent plans, specifications, shop drawings and other documentation to become fully familiar with the systems and their specified and intended performance.
ii) Furnish equipment and instruct sheet metal trade on proper use for conducting duct leakage tests. Conduct first test as a way of instructing the above trades in the presence of the Departments representative.

iii) Test relative barometric pressures in various building area, as deemed necessary by the Department's representative and at least in an areas served by different systems.
iv) Test performance and continuously record on a 24 hour basis, temperature and humidity levels where control equipment is provided for that purpose in certain critical areas.
v) Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with relevant BIS codes and test report shall be furnished by a qualified and authorized person.

13. <u>REPORTS</u>

Provide 3copies of the complete balancing and testing reports to the department. Report shall be neatly typed and bound suitable for a permanent record. Report forms shall contain complete test data and equipment data as specified and safety measures provided.

14. <u>FINAL DOCUMENTATION</u>

i) The contractor shall leave the system operating in complete balance with water and air quantities as shown on drawings. Set stops on all balancing valves and lock all damper quadrants in proper position. Secure all automatic damper and valve linkages in proper positions to provide correct operating ranges. Proper damper positions shall be marked on ducts with permanent indication. Notify the department of any areas marginal or unacceptable system performance.
ii) The above tests and procedures are mentioned herein, for general guidance and information only, but not by way of lamination to the provisions of conditions of contract and design/ performance criteria.
iii) Upon commissioning and final handover of the installation, the HVAC contractor shall submit (within 4 weeks) to the engineer-in-charge 6 (six) portfolios of the following indexed and bound together in hard cover ring binder (300 x 450 mm) in addition to the completion drawings.
    a) Comprehensive operation and maintenance manual
    b) Test certificates, consolidated control diagram and technical literature on all controls.
    c) Equipment warranties from manufacturers.
    d) Commissioning and testing reports
    e) Rating charts for all equipment
    f) Log books as per equipment manufacturers standard format
    g) List of recommended spares and consumables
    h) Any special tools required for the operation or the maintenance of the plant shall be supplied free with the plant.

iv) At the close of the work and before issue of final certificate of completion by the Engineer-in- charge, the contractor shall furnish a written guarantee indemnifying the department against defective materials and workmanship for the Defects liability period. The contractor shall hold himself fully responsible for reinstallation or replace free of cost to the department.
    a) Any defective material or equipment supplied by the contractor
    b) Any material or equipment supplied by the department which is proved to be damaged or destroyed as a result of defective workmanship by the contractor.

15. SUBMITTALS:

SUBMITTALS SHALL BE SUBMITTED FOR THE FOLLOWING EQUIPMENTS:

i) Air cooled VRV
ii) Fans
iii) Controls
iv) Expansion kit
v) Panels
vi) Air Washer
vii) Air Scrubber
viii) Heat Recovery Wheel

REQUIRED SUBMITTAL SHOULD CONTAIN THE FOLLOWING INFORMATION ALSO.

i) System summary sheet
ii) Sequence of operation
iii) Shop drawing indicating dimensions, required clearances and location and size of each field connection
iv) Power and control wiring diagrams
v) System profile analysis including variable speed pump curves and system curve. The analysis shall also include pump, motor and VFD efficiencies, job specific load profile, staging points, horsepower and kilowatt/hour consumption.
vi) Equipment data sheets

MISCELLANEOUS:

i) The above tests are mentioned herein for general guidance and information only but not by way of limitation to the provisions of conditions of Contract and Specification.
ii) The date of commencement of all tests listed above shall be subject to the approval of the Architect, and in accordance with the requirements of this specification.
iii) The contractor shall supply the Commissioning Engineer and all necessary instruments and carry out any test of any kind on a piece of equipment, apparatus, part of system or on a complete system if the architect requests such a test for determining specified or guaranteed data as given in the Specification or on the Drawings.
iv) Any damage resulting from the tests shall be repaired and/or damaged material replaced to the satisfaction of the architect.
v) In the event of any repair or any adjustment having to be made, other than normal running adjustment, the tests shall be void and shall be recommended after the adjustment or repairs have been completed.
vi) The Contractor must inform the architect when such tests are to be made, giving sufficient notice, in order that the architect or his nominated representative may be present.
vii) Complete records of all tests must be kept and 3 copies of these and location drawings must be furnished to the Architect.
viii) The Contractor may be required to repeat the test as required, should the ambient conditions at the time not given, in the opinion of the Architect, sufficient and suitable indication of the effect and performance of the installation as a whole or of any part, as required.

APPENDIX- A (TERMINOLOGY)

I) **AIR CONDITIONING**
The process of treating air so as to control simultaneously its temperature, humidity, purity, distribution and air movement and pressure to meet the requirements of the conditioned space.

II) **DRY-BULB TEMPERATURE**
The temperature of air as registered by an ordinary thermometer.

III) **WET-BULB TEMPERATURE**
The temperature registered by a thermometer whose bulb is covered by a wetted wick and exposed to a current of rapidly moving air.

IV) **DEW POINT TEMPERATURE**
The temperature at which condensation of moisture begins when the air is cooled at same pressure.

V) **HUMIDITY**
It is the amount of water vapour present in a certain volume of air.

VI) **RELATIVE HUMIDITY**
Ratio of the actual water vapor in the air as compared to the maximum amount of water that may be contained at its dry bulb temperature. When the air is saturated, dry bulb, wet bulb and dew point temperatures are all equal.

VII) **ENTHALPY**
A thermal property indicating the quantity of heat in the air above an arbitrary datum in kilo joules per kg of dry air (or in Btu per pound of dry air).

VIII) **PSYCHROMETRY**
Psychrometry is the science involving thermo dynamic properties of moist air and the effect of atmospheric moisture on materials and human comfort. It also includes methods of controlling thermal properties of moist air.

IX) **PSYCHROMETRIC CHART**
A Psychometric chart graphically represents the thermodynamic properties of moist air. If two properties are known, all the other properties can be determined with the help of psychometric chart.

X) **EVAPORATIVE AIR COOLING**
The evaporative air-cooling application is the simultaneous removal of sensible heat and the addition of moisture to the air. The water temperature remains essentially constant at the wet-bulb temperature of the air. This is a process in which heat is not added or removed from the air.

XI) **POSITIVE VENTILATION**
The supply of outside air by means of a mechanical device, such as a fan.

XII) **ATMOSPHERIC PRESSURE**

The pressure of air exerted on the surface of earth by the atmospheric column is called atmospheric pressure. At sea level, the atmospheric or barometric pressure is 760mm column of mercury (29.92 in Hg/406.8 inch water column/101.325 Kpa).

Generally atmospheric pressure is used as a datum for indicating the system pressures inair-conditioning and accordingly, pressures are mentioned above the atmospheric pressure or below the atmospheric pressure considering the atmospheric pressure to be zero. A 'U' tube manometer will indicate zero pressure when atmospheric pressure is measured.

XIII) **INDOOR AIR QUALITY (IAQ)**

Indoor air quality refers to the nature of conditioned air that circulates throughout the space/ area where one works or lives, i.e. the air we breathe when we are indoor. IAQ refers not only to comfort which is affected by temperature, humidity and odours but also to harmful biological contaminants and chemicals present in the conditioned space.

Bad Indoor Air Quality can be a serious health hazard. Carbon dioxide (C02) has been recognized by ASHRAE as the surrogate ventilation index or the only measurable variable for the indoor air contaminants.

XIIIA) **BUILDINGS RELATED ILLNESSES (BRI)**

BRI are attributed directly to the specific air-borne building contaminants like the outbreak of the legionnaire's disease after a convention and sensitivity pneumonitis with prolonged exposure to the indoor environment of the building.

XIV) **SICK BUILDING SYNDROME (SBS)**

SBS is a term, which is used to describe the presence of acute non-specific symptoms in the majority of people caused by working in buildings with an adverse indoor environment It could be a cluster of complex irritative symptoms like irritation of the eyes, blackened nose and throat, headaches, dizziness, lethargy, fatigue irritation, wheezing, sinus, congestion, skin rash, sensory discomfort from odours, nausea, etc. These symptoms are usually short-termed and experienced immediately after exposure, and may disappear when one leaves the building.

XV) **THERMAL TRANSMITTANCE**

Thermal transmission through unit area of the given building unit divided by the temperature difference between the air or some other fluid on either side of the building unit in 'steady state' conditions.

XVI) **THERMAL ENERGY STORAGE**

Storage of 'Cold Energy' sensible, latent or combination for use in central system for air-conditioning or refrigeration is called thermal energy storage. It uses a primary source of refrigeration for cooling and storing 'Cold Energy' for reuse at peak demand or for backup as planned.

XVII) **SHADE FACTOR**

The ratio of instantaneous heat gain through the shading device to that through a plain glass sheet of 3mm thickness.

XVIII) **SENSIBLE HEAT FACTOR (SHF)**

Sensible heat factor is the ratio of sensible heat to total heat, where total heat is the sum of sensible and latent heat.

XIX) **SUPPLY AIR**

The air that has been passed through the conditioning apparatus and taken through the duct system and distributed in the conditioned space is termed as supply air.

XX) **RETURN AIR**

The air that is collected from the conditioned space and returned to the conditioning equipment is termed as return air.

XXI) **RE-CIRCULATED AIR**

The return air that has been passed through the conditioning apparatus before being re-supplied to the space is called re-circulated air.

XXII) **DUCT SYSTEM**

A continuous passageway for the transmission of air which in addition to the ducts may include duct fittings, dampers, plenums and grilles &diffusers.

XXIII) **PLENUM**

An air compartment or chamber to which one or more ducts are connected and which forms part of an distribution system.

XXIV) **SUPPLY AND RETURN AIR GRILLES & DIFFUSERS**

Grilles and diffusers are the devices fixed in the air-conditioned space for distribution of conditioned supply air and return of air collected from the conditioned space for recirculation.

XXV) **FIRE DAMPER**

A closure which consists of a normally held open damper installed in an air distribution system or in a wall or floor assembly and designed to close automatically in the event of a fire in order to maintain the integrity of the fire separation.

XXVI) **SMOKE DAMPER**

A smoke damper is similar to fire damper. However, it closes automatically on sensing presence of smoke in air distribution system or in conditioned space.

XXVII) **FIRE SEPARATION WALL**

The wall provides complete separation of one building from another or part of a building from another part of the same building to prevent any communication of fire of any access or heat transmission to wall itself which may cause or assist in the combustion of materials of the side opposite to that portion which may be on fire.

XXVIII) **REFRIGERANT**

The fluid used for heat transfer in a refrigerating system, which absorbs heat at a low temperature and low pressure of the fluid and rejects heat at a higher temperature and higher pressure of the fluid, usually involving changes of state of the fluid.

XXIX) **GLOBAL WARMING POTENTIAL (GWP)**

Global Warming can make our planet and its climate less hospitable and more hostile to human life. It is, therefore, necessary to reduce emission of greenhouse gases such as Co2, Sox, Nox and refrigerants. The potential of are refrigerant to contribute to Global Warming is called its GWP. Long atmospheric life time of refrigerants results in Global Warming unless the emissions are controlled.

XXX) **OZONE DEPLETION POTENTIAL (ODP)**

The potential of refrigerant or gasses to deplete the Ozone in the atmosphere is called ODP. The ODP values for various refrigerants are as under:-

R-11	1.000
R-12	0.820
R-22	0.034
R·123	0.012
R-134a Nil	

Due to high OPD of 1, R-22 &R-123 their use in the air conditioning and refrigeration is being phased-out.

APPENDIX-B (SCHEDULE OF TECHNICAL DATA)

Contractor should furnish technical data as mentioned below, of the equipment and accessories offered by him as per scheme given in schedule of equipment and Bill of Quantities.

A) VRF/ Split Air Conditioning System:

INDOOR

1.	Make	
2.	Casing	
3.	Type:	Ductable/ Cassette/ High wall
4.	Dimension	MxMxH (M)
5.	Cooling Capacity	
6.	Air quantity at max. Speed And 1 m long duct collar	CMH
7.	Air quantity at min. Speed And 1.0 m. Long duct collar	CMH
8.	Whether auxiliary drain pan Provided:	Yes/No.
9.	Make & model of room thermostat.	
10.	Whether acoustic lined duct collar included in Unit price.	
11.	Does Indoor Unit have return air plenum.	Yes/No.
12.	Noise Level at 1 m distance:	

OUTDOOR

1.	Manufacturer
2.	Type
3.	Model
4.	Overall dimensions (mm)
5.	Operating Weight (kg.)
6.	No. of fans
7.	CMH per fan
8.	Outlet velocity (Mts. Per min)
9.	Tip speed (Mts per min)
10.	Compressor Type
11.	Vibration isolator
12.	Noise Level at 1 m distance:

B) DX type Air Handling Units/Heat Recovery unit

1.0	Make	
1.1	Casing	
1.2	Coil	
2.0	Type:	horizontal/ vertical
3.0	Dimension	MxMxH (M)
4.0	Cooling coil	
4.1	Coil area	Sq.M
4.2	No. of rows	Nos.
4.3	No. of fins/cm	
4.4	Tube dia (Outer dia)	mm
4.5	Thickness of tube	mm

5.0	Material of casing:	CRCA/GI
6.0	Air quantity at max. Speed And 1 m long duct collar	CMH
7.0	Air quantity at min. Speed And 1.0 m. Long duct collar	CMH
8.0	Whether auxiliary drain pan Provided:	Yes/No.
9.0	Make & model of room thermostat.	
10.0	Water valves.	
10.1	Type 2 way/ 3 way	
10.2	Motorized/solenoid.	
10.3	Make/dia.	
11.0	Type of shut off valves	
12.0	Whether acoustic lined duct collar included in Unit price.	
13.0	Does FCU/ AHU have return air plenum.	Yes/No.
14.0	Noise Level at 1 m distance:	

(C) INSULATION (For each application)

(D) FANS (For each Type and application)

1. Manufacturer
2. Type
3. CFM
4. Static Pressure MM WG
5. Motor H.P.
6. Insulation Class
7. Outlet Vel. FPM
8. R.P.M
9. Type of Drive
10. Noise Level DB

F) GRILLES/DIFFUSERS/DAMPERS: Make, Materials and Gauge

1. Fire Dampers - UL Listed
2. Grilles
3. Louvers
4. Diffusers
5. Duct Dampers

G) Duct Insulation Material

1. Thermal Conductivity
2. Duct Insulation thickness

APPENDIX-C (TESTING AND MEASUREMENT NOTES)

A. TEST INSTRUMENTS

1. All instruments for testing shall be provided by the air conditioning contractor.
2. Thermometers used for measurement of temperature of *water l* refrigerant shall have graduation of 0.1 deg C and shall be got calibrated from N.P.L. or any recognized test house beforehand.
3. Thermometers used in the psychrometers shall have graduations of 0.2 deg C and shall be calibrated as at (2) above.
4. Pressure gauges shall also be got calibrated beforehand from a recognized test house.
5. Orifice type of flow meters shall be used for measuring flow rate through the condensers and chillers.

B. CAPACITY COMPUTATIONS

1. Air handling unit (chilled water type):
   The capacity shall be computed from the water temperature and water flow measurement a tolerance of + 5% from the tender documents value shall be acceptable in the capacity so computed. Air quantity shall be measured in the supply duct and checked with the quantity specified in the tender documents. A tolerance of ±10% in the air quantity shall be acceptable. The enthalpy difference of air entering and leaving the coil shall be computed from air temperature and recorded.

2. Air handling unit (DX type):
   The capacity shall be computed from the air quantity measured in the supply air duct and the enthalpy difference between the air entering leaving coil. Air quantity measured shall be checked with that recorded in the tender documents. A tolerance of ±10% from tender documents value shall be acceptable.

3. For the purpose of system capacity, the refrigeration tonnage obtained from the main refrigeration plant will be accepted.

4. If due to any reason, internal load mentioned in the tender specifications is not available psychometric computations for actual load conditions will, be done and the plant, if found satisfactory will be accepted.

APPENDIX-D (MAINTENANCE)

This section covers the maintenance schedule during 1-year free warranty period.

The maintenance provided during the warranty period shall be fully comprehensive and shall include but not limited to all equipments, labour part and emergency calls providing and site response within 24 hours. However, during the maintenance period after the warranty is over, the materials shall be arranged by the department if any replacement is warranted.

AIR WASHER	MONTHLY INSPECTION	1) Inspect all air handling and fan coil units. 2) Check all air filters and clean or change filters as necessary. 3) Check all water coils, seals and pipelines for leaks and rectify as necessary. 4) Check and re-calibrate modulating valves and control. Adjust and rectify as necessary to ensure compliance with the original specifications. 5) Purge air from all water coils. 6) Check all fan bearings and lubricate with grease as necessary. 7) Check the tension of belt drives and adjust as necessary. 8) Check and clean all condensate pans, trays and drains. 9) Check, measure and recalibrate all sensors if necessary. 10) Check, clean and service all smoke detectors. Carry out a system test to ensure that the smoke detector will trip the AHU's. 11) Check all spring vibration isolators for abnormal vibration. Rectify as necessary. 12) Coil to be cleaned by a) Spray of high press clean water(not exceeding 30 psi) b) With chemical spray ,if necessary.
AIR DISTRIBUTION SYSTEM	MONTHLY AND ANNUAL INSPECTION PRIOR TO EXPIRY OF WARRANTY	1) Check operations of all modulating and fixed dampers controlling air flow through unit. Lubricate all damper bearing and linkages as necessary. 2) Carry out space temperature checks on air conditioned areas with thermo hydrographs. Balance

	PERIOD	air flow as necessary to compliance with requirement of original specifications. These checks include the calibration of sensors, thermostat, etc. 3) Check noise level of discharged air from diffusers.
VENTILATION	MONTHLY CHECK AND ANNUAL INSPECTION PRIOR TO EXPIRY OF WARRANTY PERIOD	1) Check, adjust as necessary the air flow of all fans are in compliance with the original specification. 2) Check the tension of all belt drives and adjust as necessary. 3) Check and lubricate all fan bearings. 4) Tighten motor terminals. 5) Check starter contacts. 6) Test and calibrate over-load settings. 7) A system check shall be carried out for all mechanical ventilation (MV), pressurization and exhaust system to verify the performance of the system.
PIPING SYSTEM	MONTHLY AND ANNUAL INSPECTION PRIOR TO EXPIRY OF WARRANTY PERIOD	1) Check all piping system for leaks and repairs these where they have occurred. 2) Check for damages and deterioration of insulation or sheathings. Rectify as necessary.
	CONSUMABLE MATERIALS	CONSUMABLE MATERIALS The department shall supply the following consumable materials as and when required:- 1) The oils and grease required for lubrication of compressors, fan bearings, motors bearings, pivots and other moving parts. 2) All refrigerant required for topping up. Refrigerant loss if due to manufacturing defect or due to negligence shall be made good by the contractor. 3) All consumable filter elements/rolls. 4) All chemical for the correct chemical treatment of the cooling tower and chilled water system. 5) All carbon brushes required to replace worn

		brushes in electric motors. 6) All electric contact points required to replace worn electric contact points in switchgears, motor starter gears, electronic control gears and electric relays. 7) All electric fuses required to replace blown fuses. Just before the expiry of the warranty of the contact, the contractor shall carry out a complete system operability test on all the system or sub systems as called for in the contract. The purpose of the test is to verify that the performance of all the systems or sub-systems in the contract is in accordance to the specifications. All test shall be carried out in the presence of the Engineer-in-charge or his representative. The warranty period is deemed to be over if the department or his representative is completely satisfied with the system performance during the test.

APPENDIX – E (PREAMBLE TO SCHEDULE OF QUANTITIES)

1. All items of work under this Contract shall be executed strictly to fulfill the requirement laid down under" Basis of Design" in the specifications. Type of equipment, material, specification, methods of installation and testing and type of control shall be In accordance with the specification, approved shop drawing and relevant International Standards, however capacity of each component and their quantities shall as fulfill the above-mentioned requirement.
2. The unit rate for all equipment's or materials cost in RUPEES for equipment and material including all taxes and duties and also including forwarding, freight, insurance and transport into Contractor's store at site storage' installation 'testing balancing ' commissioning and other work required.
3. The rate for each item of work included in the Schedule of Quantities shall' unless expressly stated otherwise, include cost of:
    i. All materials. Fixing materials. Accessories, appliances tools, plants, equipment transport, labour and incidentals required in preparation for and in the full and entire execution as per Specification and Drawings.
    ii. Wastage on materials and labour.
    iii. Loading, transporting, unloading, handling/double, hoisting to all levels. Setting, fitting, and fixing in position, protecting, disposal of debris and other labour necessary in and for the full and entire execution and for the job in accordance with the contract documents, good practice and recognize principals.
    iv. Liabilities, obligations, and risks arising out of Conditions of Contract.

4. All requirements of Specification, whether such requirements are mentioned in the item or not. The Specification and Drawing where available, are to be read as complimentary to and part of the Schedule of Quantities and any work called for in one shall be taken as required for all.

5. In the event of conflict between Schedule of Quantities and other documents including the Specification, the most stringent shall apply. The interpretation of the Engineer in charge shall be final and binding.
6. All equipment, quantities, and technical data indicated in this Schedule are for Contractor's guidance only; these are based on the documents prepared by the Consultant. This schedule must be read in conjunction with other documents. The Contractor shall be paid for the actual quantity of work executed by him in accordance with the approved Shop Drawing at the contract rates.
7. This Schedule shall be fully priced and the extensions and totals duly checked. The rates for all items shall be filled in INK including NIL items.
8. No alteration whatsoever is to be made to the text or quantities of this schedule unless Consultant authorizes such alteration in writing. Any such alterations, cuts or additions shall unless authorized in writing, be disregarded when tender documents are considered.
9. In the event of an error occurring in the amount of the Schedule, as a result of wrong extension of the unit rate and quantity, the unit rate quoted by the tenderer shall be regarded as firm and the extensions shall be amended on the basis of rates.
10. Any error totaling the amount column and in carrying forward total shall be corrected, any error, in description or in quantity, omission of items from this Schedule shall not vitiate this corrected but shall corrected and deemed to be variation required by the engineer in charge.
11. The Contractor shall procure and bring Materials/ Equipment to the site only on the basis of drawing approved for construction and shop drawings and not on the Contractor's requisition for Engineer in charge supplied materials.

TECHNICAL SPECIFICATIONS

SECTION - I SANITARY FIXTURES

1. SCOPE OF WORK

1.1 Work under this section shall consist of furnishing all Material and labour as necessary and required to completely supply, installation, testing and commissioning all Sanitary Fixtures, brass and chromium plated fittings, stainless steel sinks and accessories as required by the drawings and specified hereinafter or given in the Schedule of Quantities.

1.2 Without restricting to the generally of the foregoing the Sanitary Fixtures shall include all Sanitary Fixtures, C.P. fittings and Accessories etc. necessary and required for the Building.

1.3 Whether specifically mentioned or not all Fixtures and appliances shall be provided with all fixing devices, nuts, bolts, screws, hangers as required.

2. GENERAL REQUIREMENTS

2.1 All Fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Schedule of Quantities, Specifications and Drawings.

2.2 All Fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per Architectural/ Interior designers' requirements. Wherever necessary the fittings shall be centered to dimensions and pattern desired.

2.3 Fixing screws shall be half round head Chromium Plated brass with C.P. washers wherever required as per directions of Engineer-in-Charge.

2.4 All appliances, fittings and fixtures shall be fixed in a neat workmanlike manner true to Levels and Heights shows on the drawings and in accordance with the manufacturer's recommendations. Care shall be taken to fix all Inlet and Outlet Pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling, plaster, paint, insulation or terrace shall be made good at Contractors cost.

2.5 When directed, Contractor shall install Fixtures and accessories in a mock-up room for the approval of the Engineer-in-Charge. Sample room Fixtures may be reused on the works if undamaged, but no additional payment for fixing or dismantling shall be admissible.

2.6 All materials shall be rust proof, material in direct or indirect contact shall be compatible to prevent Electrolytic or chemical (bi metallic) corrosion.

2.7 Fixtures shall be mounted rigid, plumb and true to alignment.

3.0 EUROPEAN W.C.

3.1 European W.C. shall be wash down, single or double siphonic type, wall mounted set, flushed by means of exposed or concealed type flushing cistern, as specified in Schedule

of Quantities. Flush pipe/bend shall be connected to the W.C. by means of suitable rubber adapter. Wall hung W.C. shall be supported by C.I. floor mounted chair.

3.2 Each W.C. seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C.

4. **W.C.**

4.1 W.C. pan shall be Arabic pattern, of size as specified in the Schedule of Quantities. Each W.C. shall be provided with a 100 mm dia cast iron or porcelain P or S trap with or without vent horn.

4.2 W.C. shall be flushed by means of an exposed or concealed type cistern or as specified in Schedule of Quantities.

4.3 The W.C. shall be fixed in level in a neat workmanlike manner. The W.C. and trap shall be set in cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size) joints between W.C. and flush pipe shall be made with a putty or white lead and linseed oil and caulked well or with an approved rubber joint.

5.0 **URINALS**

5.1 Urinals shall be white glazed Vitreous China flat back half stall or lip type as specified in Schedule of Quantities.

5.2 Half stall Urinals shall be provided with 15 mm dia C.P. spreader, 32 mm dia C.P. domical waste and C.P. cast brass bottle trap with pipe and wall flange, and shall be fixed to wall by one C.I. bracket and two C.I. wall clips as recommended by manufacturers complete and as directed by Engineer-in-Charge.

5.3 Half stall urinals shall be fixed with C.P. Brass screws and shall be provided with 32 mm dia Domical Waste leading to Urinal trap.

5.4 Urinals shall be flushed by means of automatically sensor operated flushing system as specified in Schedule of Quantities.

5.5 Waste pipes for urinals shall be of the following:
(a) G.I. /uPVC Pipes

Waste pipes may be exposed on wall or concealed in chase as directed by the Engineer-in-Charge. Specifications for waste pipes shall be same as given in Sub Section / or as given in the BOQ.

6.0 **SINKS**

6.1 Sinks shall be of precast Terrazzo Marble or White Glazed fire clay or Vitreous China or Stainless Steel or any other material as specified in the Schedule of Quantities.

6.2 Hand Wash Sinks and Process Sinks shall be of Stainless Steel and may be supplied by the Owner, if desired by him .

6.3 Each sink shall be provided with R.S. or C.I. brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable angle iron clips or brackets as recommended by the

manufacturer. Each sink shall be provided with 40 mm dia C.P. waste with chain and plug or P.V.C. waste. Fixing shall be done as directed by Engineer-in-Charge.

6.4 Supply fittings for sinks shall be mixing fittings or C.P. Censor Operated (Battery/Electrical) taps as specified in the Schedule of Quantities.

7.0 WASH BASINS

7.1 Wash basins shall be White Glazed Vitreous China of size, shape and type specified in the schedule of quantities or as recommended by the Engineer-In-Charge.

7.2 Each Basin shall be provided with painted MS angle or CI brackets and clips and the Basin securely fixed to the wall / counter slab. Placing of Basin over the brackets without proper fixing shall not be accepted. The cost of fixing the basin shall be inclusive of supply and installation of brackets as described above.

7.3 Each Basin shall be provided with 32 mm dia CP Waste with overflow, pop-up waste or rubber plug and CP Brass chain as specified in the BOQ.

8.0 MIRRORS

8.1 Mirrors shall be electro coated copper 6 mm thick of guaranteed reputed make. The size shall be as specified in the Schedule of Quantities or shown on the drawings. The image shall be clear and without waviness at all angles of vision.

8.2 Mirrors shall be provided with backing of 12 mm thick Marine Plywood sheet fixed with C.P. brass semi-round headed screws and cup Washers or C.P. Brass Clamps as specified or instructed by Engineer-in-Charge.

9.0 SHOWER SET

9.1 Shower set shall comprise of single lever mixer or four-way diverter with two C.P. brass concealed stop cocks, with bath spout or as given in the Schedule of Quantities.

9.2 Each shower set shall also be provided with C.P. shower arm with wall flange and shower head of approved quality as specified in the Schedule of Quantities.

9.3 Concealed stopcocks shall be so fixed as to keep the wall flange clear off the finished wall. Wall flanges embedded in the finishing shall not be accepted.

10.0 ACCESSORIES

10.1 Contractor shall install all Chromium Plated and porcelain accessories as shown on the drawings or directed by Engineer-in-Charge, and given in the Schedule of Quantities.

10.2 All C.P. Accessories shall be fixed with C.P. brass half round head screws and cup washers in wall with rawl plugs or nylon sleeves and shall include cutting and making good as required or directed by Engineer-in-Charge.

10.3 Porcelain accessories shall be fixed in walls and set in cement mortar 1:2 (1 cement: 2 coarse sand) and fixed in relation to the tiling work.

11.0 URINAL PARTITIONS

11.1 Urinal partitions shall be white glazed vitreous china or 25mm thick marble of size specified in the Schedule of Quantities.

11.2 Porcelain partitions shall be fixed at proper heights with C.P. brass bolts, anchor fasteners and M.S. clips as recommended by the manufacturer and directed by Engineer-in-Charge.

12.0 PAN CONNECTOR

The WC pan connector shall be Flexible, soft and shall be made of single body construction with integral fins, made from EVA (Ethyl Vinyl Acetate). The pan connector must confirm to the BS: 5627: 1984. The pan connector must be supplied with factory fitted spring loaded seal guard.

The connector shall not be allowed to come in contact with mineral oil, grease, putty or any compound containing mineral oil or grease.

The pan connectors must be stored away from the direct sunlight and flames.

While fixing of the pan connector with the Soil pipe, the pipe must be reasonably clean and smooth on the inner surface; in case the soil piping is in C.I. then supplier supplied bush / adaptor shall be used. The connector socket is pushed fully home onto the pan spigot, thereafter the WC is placed in position gently pushing the fitment to ensure that the connector end fits into the Spigot of the pipe. The pan connector must be pushed in such a way as to ensure that the seals and fins turn inward to ensure proper sealing.

13.0 MEASUREMENT

13.1 Rates for fixing of Sanitary Fixtures Accessories, urinal partitions shall include all items and operations stated in the respective specifications and Schedule of Quantities and nothing extra is payable.

13.2 Rates for all items under specifications above shall be inclusive of cutting holes and chases and making good the same, C.P. screws, nuts, bolts and any fixing arrangements required and recommended by Manufacturers, Testing and Commissioning.

SECTION - II **SOIL, WASTE & VENT PIPES**

SCOPE OF WORK

1.1 Work under this section shall consist of furnishing all labor, materials, equipment's and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes as required by the drawings, specified hereinafter and given in the Schedule of Quantities.

1.2 Without restricting to the generally of the foregoing, the soil, waste, vent and rainwater pipes system shall include the followings:

a) Vertical and horizontal Soil, Waste and Vent Pipes, Rainwater Pipes and Fittings, Joints Clamps and connections to Fixtures.
b) Connection of pipes to Gully Traps & Manholes etc.
c) Rain water pipes as specified
d) Testing of all pipes.

2. **GENERAL REQUIREMENTS**

2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of Engineer-in-Charge / Owner.

2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

2.3 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

2.4 Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.

2.5 Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.

2.6 All works shall be executed as directed by Engineer-in-Charge / Owner.

3. **CAST IRON PIPES & FITTINGS**

3.1 **Pipes**

(a) All pipes shall be straight and smooth and inside free from irregular bore, blowholes, cracks and other manufacturing defects. Pipes shall be sand cast iron pipes conforming to BIS/ NBS or centrifugally cast (spun) iron pipes conforming to BIS/NBS as specified in Bill of Quantities.

(b) Standard weight, dimensions and pig lead required for joints shall be as follows:

For pipes conforming to table as below (sand cast iron soil pipes and fittings)

Nominal Dia (MM)	Thickness (MM)	Overall Weight for 1.8 m long pipe (Kg.)	Minimum depth of lead joint from the lip of socket (MM)	Quantity of lead per Joint (Kg.)
50	5	11.41	25	0.50
75	5	16.52	25	0.66
100	5	21.67	25	1.00
150	5	31.92	38	1.25

(c) **Tolerance**

Acceptable tolerance for pipes to I.S: 3989 shall be as follows:-

- Wall thickness - 15%
- Length +20 mm
- Weight - 10%

(d) In order to ensure that required quantity of Lead is poured into the joint and to control wastage of Lead, at the beginning, three samples shall be made and the quantum of lead per joint shall be approved by the Engineer-in-Charge / Owner.

(e) The actual consumption of Lead should be within ± 5% of the approved sample job subject to the provision that variation ±20% shall be allowed over the theoretically quantity L due to dimensional tolerances allowed as per Standards. This variation includes allowances of Wastage also.

3.2 **Fittings**

(a) Fittings used for C.I. drainage pipe shall conform to BIS/NBS. Wherever possible junction from branch pipes shall be made by a 'Y-tee.'

(b) Fittings shall conform to the same Standard. The Contractor shall use pipes and fittings of matching specifications.

(c) Fittings shall be of the required degree of curvature with or without access doors.

(d) Access door shall be made up with 3mm thick insertion rubber washer and white Lead. The bolts shall be lubricated with grease or white Lead for easy removal later. The fixing shall be air and watertight.

3.3 **Fixing**

(a) All vertical pipes shall be fixed by M.S. clamps truly vertical. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a Cowl (terminal guard).

(b) Horizontal pipes running along ceiling shall be fixed on structural adjustable clamps of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.

(c) Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the building Contractor for making such

provisions in the structure as necessary. All damages shall be made good to restore the surface.

3.4 **Jointing**

C.I pipes wherever used shall be jointed with refined pig lead.

(a) **Pig Lead Joint**

A sufficient skein or jute rope shall be caulked to leave a minimum space for the pig lead to be poured in. After pouring the lead shall be caulked into the joint with caulking tool and hammer. All surplus lead shall be cut and joint left flush with the rim of the socket neatly.

(b) **Jointing (Synthetic Sealant Compounds, Alternate to Lead Joints)**

The sealant shall be manufactured in two separate compounds of different colors "Black" and "White", and used for jointing of C.I. in place of lead joints, as per approval of the engineer-in-Charge / Owner.

The sealant compound shall be of approved make and manufacturer.

The sealant shall be manufactured in two separate compounds of different colors "Black" and "White", and used for jointing of C.I. in place of lead joints, as per approval of the engineer-in-Charge / Owner.

The compound shall have high bonding strength and shall be non-toxic. The specified density shall be 1.95 grams / c.c. or as per approved manufacturer specifications.

The two separate compounds shall be mixed homogeneously from the supplied packets. In cold conditions both unmixed packets are to be heated in Sun or heated to room temperature (25^0 C) to make them more workable for mixing. The pipe joint is cleaned to make it free from dust, grease, oil, cement splashes and all other foreign matters and contaminants. The joint is made dry. Hemp yarn is provided as usual in pipe joint as back filler. The mixed compound is to be forced into the lap of pipe joint with Caulking tool, MS Flat piece or by Hand. Proper pressing of compound is necessary to avoid air entrapment. The joint is not to be disturbed till the compound is hardened.

The mixed compound shall not be kept without use for more than 30 to 40 minutes. The expiry date of the material shall also be checked before use and in case of expiry of material, the lot shall be rejected.
The compound shall be allowed to cure at room temperature with a setting time of 4 to 6 hours.

Consumption of mixed compound shall be as per the following table:

Diameter of pipe (mm)	Consumption per joint (grams)
50	130 to 150
80	150 to 170
100	200 to 250
150	250 to 300

To ensure proper quantity of compound used in to the joint, three samples shall be made and the quantum of compound per joint shall be approved by the Engineer-in-Charge / Owner. The actual consumption should be within ± 5% of the approved samples.

3.5 **C.P./Stainless Steel Gratings**

Floor and Urinal Traps shall be provided with 100-150 mm square or round C.P/Stainless steel grating, with rim of approved design and shape. Minimum thickness shall be 4-5 mm or as specified in the Schedule of Quantities.

4. **CLEANOUT PLUGS**

Contractor shall provide brass cleanout plugs as required. Cleanout plugs shall be threaded and provided with key holes for opening. Cleanout plugs shall be fixed to the pipe by a male threaded adaptor.

5. **WASTE PIPE FROM APPLIANCES**

5.1 Waste pipe from appliances e.g. wash basins, sinks, urinals, bathtubs, water coolers shall be of galvanized steel/uPVC as given in the Schedule of Quantities or as shown on the drawings.

5.2 All pipes shall be fixed in gradient towards the outfalls of drains. Pipes inside a toilet room shall be in chase unless otherwise shown on drawings. Where required pipes may be run at ceiling level in suitable gradient and supported on structural clamps. Spacing for clamps for such pipes shall be as follows:-

	Vertical	Horizontal
G.I pipes	300 cms	240 cms

5.3 **Galvanized Iron Pipes**

Pipes shall be galvanized iron tubes (medium class) and quality certificates shall be furnished. Pipes shall be provided with all required fittings e.g. Tees, Couplings, Bends, Elbows, Unions, Reducers, Nipples, Plugs. All G.I. waste pipes shall be terminated at the point of connection with the appliance with an outlet of suitable diameter.

6. **CEMENT CONCRETE**

Cast Iron Soil and Waste pipes under floors in sunken slabs and in wall chases (When cut specially for the pipe) shall be encased in cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 12 mm size) 75 mm in bed and all-round. When pipes are running well above the structural slab, the encased pipes shall be supported with suitable cement concrete pillars of required height and size at intervals as directed by Engineer-in-Charge/Owner.

7. **PAINTING**

7.1 Wherever CI pipes are used, it shall be painted with two or more coats of synthetic enamel paint to give an even shade. All surfaces shall be thoroughly cleaned before painting.

7.2 Paint shall be of approved quality and shade, pipes shall be painted in accordance with approved pipe color code.

7.3 Waste pipes in chase shall be painted with two coats of Bitumen paint, covered with polythene tape and a final coat of bitumen paint. Exposed pipes shall be painted with two or more coats of Synthetic enamel paint.

7.4 C.I. pipes below ground and covered in cement concrete shall not be painted.

8. CUTTING AND MAKING GOOD

Pipes shall be fixed and tested as buildings proceeds. Contractor shall provide all necessary holes cutouts and chases in structural members as building work proceeds. Wherever holes are cut or left originally, they shall be made good with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size) or cement mortar 1:2 (1 cement: 2 coarse sand) and the surface restored as in original condition.

9. INSPECTION & TESTING

9.1 Inspection

Work should be inspected during installation and tests applied on completion, care being taken that, all work which is to be encased for concealed is tested before it is finally enclosed.

Inspection should be carried out to ensure the following:

(a) Work accords with the drawing and specifications.

(b) All pipe brackets, clips etc. are securely fixed.

(c) Fixtures are correctly spaced.

(d) Pipe is protected where necessary by Thermal Insulation.

(e) Embedded pipe work is properly protected before sealing-in

(f) All access covers, caps or plugs.

- Are accessible
- Are so made that the internal faces truly complete in internal bore.
- Cause no obstruction in the pipe bore
- Are well joined.

9.2 Testing

The soil, waste piping system and rain water should be tested after installation as follows:

(a) **Water Test**

The pipes shall be tested after installation & before the appliances are connected, preferably in sections so as to limit the static head of 4.5m. The pipe shall be filled with water for at least 10 minutes. After filling, pipes shall be struck with a hammer and inspected for blow holes and cracks. Then it will be necessary to seal all openings and leaks at joints immediately as observed during the test and all defective pipes shall be rejected and removed from the site. Pipes with minor sweating shall be accepted at the discretion of the Engineer-in-Charge/Owner.

(b) **Smoke Test**

Alternatively, the Contractor may test all Soil, Waste and Rainwater stacks by smoke testing machine. The smoke test shall be carried out as under:

Smoke shall be pumped into the stack after plugging all inlets and connections at the lowest points from a smoke testing machine which consists of a bellow & burner. The material usually burnt is greasy cotton waste which gives out a clear pungent smoke which is easily detected by sight as well as by smell, if there is leak at any points of the pipe. The top end shall however be left open. The stack shall then be observed for leakiness and all defective pipes and fittings removed or repaired as directed by the Engineer-in-Charge / Owner.

9.3 A test register shall be maintained and all entries shall be signed and dated by Contractors and Engineer-in-Charge/Owner.

10. MEASUREMENTS

10.1 General

(a) Rates for all items quoted shall be inclusive of all work and items given in the above-mentioned specifications and Schedule of Quantities and applicable for the work under floor, in shafts or at ceiling level at all heights and depths.

(b) All rates are inclusive of cutting holes and chases in RCC and masonry work and making good the same.

(c) All rates are inclusive of pre testing and on-site testing of the installations, materials and commissioning.

10.2 **Pipes** (Unit of measurement. Linear meter to the nearest centimeter)

(a) C.I. (L.A) pipes shall be measured along the center line when fixed, correct to a centimeter including all fittings and lead caulked joints along its length.

(b) C.I. pipes shall be measured overall along the center line correct to a centimeter including all fittings along its length. The rate for these pipes shall be inclusive of all fittings, holder bat clamps, lead caulked joints and all other items described in the Schedule of Quantities. Traps structural clamps and cement concrete shall however be paid separately under the relevant item.

(c) G.I., S.C.I & P.V.C. Polythene pipe shall be measured per running meter correct to a centimeter for the finished work, which shall include fittings e.g., Bends, Tees, Elbows, Reducers, Crosses, Sockets, Nipples and Nuts but exclude brass or Gunmetal Taps (Cocks), Valves lead connection pipes and shower rose. The length shall be taken along center line of the pipes and fittings. All pipes and fittings shall be classified according to their diameter, method of jointing and fixing substance, quality and finish. The diameter shall be nominal diameter of internal bore. The pipes shall be described as including all cutting and waste. In case of fittings of unequal bore, the largest bore shall be measured.

10.3 Cement concrete around pipes shall be measured along the center of the pipe line measured per linear meter and include any Masonry Supports, Shuttering and Centering Cutting complete as described in the relevant specifications.

10.4 Slotted angles/channels shall be measured per linear meter of finished length and shall include support bolts and nuts embedded in masonry walls with cement concrete blocks and nothing extra will be paid for making good the same.

10.5 **Painting**: Painting of pipes shall be measured per running meter and shall be inclusive of all fittings and clamps. No deduction for fittings shall be made.

10.6 **Structural Clamps:** Structural clamps and U clamps shall be paid for by weight per kg. rates shall be inclusive of all nuts, bolts, dash fasteners, drilling, cutting, welding. Weight of clamps shall be calculated from the actual length used in structural members multiplied by its theoretical weight given in manufacturers catalogues. Weight of nuts, bolts, shall not be taken into account. M.S holder bats for holding C.I pipes in walls shall not be measured separately and it shall be a part of fixing C.I pipes.

10.7 **Excavation for soil pipes**: No extra payment shall be admissible with respect to excavation, refilling and disposal of surplus earth for Cast Iron Soil and Waste Pipes.

END OF SECTION – II

SECTION - III EXCAVATION FOR PIPE LINE

1.0 EXCAVATION

The excavation for pipe works shall be open cutting unless the permission of the Engineer-in-Charge for the ground to be tunneled is obtained in writing. Where sewers have to be constructed along narrow passages, the Engineer-in-Charge may order the excavation to be made partly in tunnel and in such cases the excavated soil shall be brought back later on for refilling the trenches or tunnel.

1.1 Opening out Trenches

In excavation the trenches, etc. the solid road metalling, pavement, curbing etc. and turf is to be placed on one side and preserved for reinstatement when the trenches or other excavation shall be filled up. Before any road metal is replaced, it shall be carefully shifted. The surface of all trenches and holes shall be restored and maintained to the satisfaction of the Engineer-in-Charge and of the Owners of the roads or other property traversed and the Contractor shall not cut out or break down any live fence of trees in the line of the proposed works but shall tunnel under them, unless the Engineer-in-Charge shall order to the contrary.

The Contractor shall grub up and clear the surface over the trenches and other excavations of all trees, stumps roots and all other encumbrances affecting execution of the work and shall remove them from the site to the approval of the Engineer-in-Charge.

1.2 Obstruction of Roads

The Contractor shall not occupy or obstruct by his operation more than one half of the width of any road or street and sufficient space shall then be left for public and private transit, he shall remove the materials excavated and bring them back again when the trench is required to be refilled. The Contractor shall obtain the consent of the Engineer-in-Charge in writing before closing any road to vehicular traffic and the foot walks must be clear at all times.

1.3 Removal of Filth

All night soil, filth or any other offensive matter met with during the execution of the works, immediately after it is taken out of any trench, sewer or cess pool, shall not be deposited on to the surface of any street or where it is likely to be a nuisance or passed into any sewer or drain but shall be at once put into the carts and removed to a suitable place to be provided by the Contractor.

1.4 Excavation to be Taken to Proper Depths

The trenches shall be excavated to such a depth that the pipes shall rest on concrete or on firm bedding as described in the several clauses relating to these so that the inverts may be at the levels given in the sections. In bad ground, the Engineer-in-Charge may order the Contractor to excavate to a greater depth than that shown on the drawings and to fill up the excavation to the level of the sewers with concrete, broken stone, gravel or other materials. For such extra excavation and concrete, broken stone, gravel or other materials, the Contractor shall be paid extra at rates laid down for such works in the schedule, if the extra work was ordered by the Engineer-in-Charge in writing, but if the Contractor should excavate the trench to a greater depth than is required without a

specific order to that effect in writing of the Engineer-in-Charge the extra depth shall have to be filled up with concrete 1:5:10 mix (1 cement: 5 fine sand: 10 stone aggregate 40mm nominal size) at the Contractor's own costs and charges to the requirements and satisfactions of the Engineer-in-Charge.

1.5 **Refilling**

After the pipes or other work has been laid and proved to be water tight, the trench or other excavated portions shall be refilled. Utmost care shall be taken in doing this, so that no damage shall be caused to the sewer and other permanent work. The filling in the haunches and upto 75 cms above the crown of the sewer shall consist of the finest selected materials placed carefully in 15 cms layers and flooded and consolidated. After this has been laid, the trench and other excavation shall be refilled carefully in 15 cms layers with materials taken from the excavation, each layer being watered to assist in the consolidation unless the Engineer-in-Charge shall otherwise direct.

1.6 **Contractor to Restore Settlement and Damages**

The Contractor shall, at his own costs and expenses, make good promptly during the whole period for the works in hand, any settlement that may occur in the surfaces of roads, beams, footpaths, gardens, open spaces etc. Whether public or private areas caused by his trenches or by his other excavations and he shall be liable for any accidents caused thereby. He shall also, at his own expenses and charges, repair and make good and damage done to buildings and other property. If in the opinion of the Engineer-in-Charge he fails to make good such works with all practicable dispatch, the Engineer-in-Charge shall be at his liberty to get the work done by other means and the expenses there of shall be paid by the Contractor or deducted from any money that may be or become due to him or recovered from him by any other manner according to the law of the land.

The Contractor shall at his own costs and charges provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled, surplus soil shall be immediately removed, the surface shall be properly restored and roadways and sides shall be left clean.

1.7 **Disposal of Surplus Soil**

The Contractor shall at his own costs and charges provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled the surplus soil shall be immediately removed, the surface properly restored and roadways and sides left clear.

1.8 **Timbering of Sewer and Trenches**

a) The Contractor shall at all times support efficiently and effectively the sides of the sewer trenches and other excavations by suitable timbering, piling and sheeting and they shall be close, timbered in loose or sandy strata and below the surface of the sub soil water level.

b) All timbering, sheeting and piling with their waling and supports shall be of adequate dimensions and strength and fully braced and strutted so that no risk of collapse or subsidence of the walls of the trench shall take place.

c) The Contractor shall be held responsible and will be accountable for the sufficiency of all timbering, branches, sheeting and piling used as also for all damage to persons and

property resulting from improper quality, strength, placing, maintaining or removing of the same.

1.9 **Shoring of Buildings**

The Contractor shall shore up all buildings, walls and other structures, the stability of which is liable to be endangered by the execution of the work and shall be fully responsible for all damages to persons or property resulting from any accident.

1.10 **Removal of Water from Sewer, Trench etc.**

The Contractor shall at all times during the progress of the work keep the trenches and excavations free from water which shall be disposed off by him in a manner as will neither cause injury to the public health nor to the public or private property nor to the work completed or in progress nor to the surface of any roads or streets, nor cause any interference with the use of the same by the public.

1.11 **Width and Depth of Trench**

The Engineer-in-Charge shall have power by giving an order in writing to the Contractor to increase the maximum width in respect of which payment will be allowed for excavation in trenches for various classes of sewer, manholes, and other works in certain lengths to be specifically laid down by him, where on account of bad ground or other unusual conditions, he considers that such increased widths are necessary in view of the site conditions.

2.0 **MEASUREMENTS**

2.1 **Excavation**

Measurement for excavation of pipe trenches shall be made per linear metre under the respective category of soil classification , as given in Schedule of Quantities.

2.1.1 Trenches shall be measured between outside walls of manholes at top and the depth shall be the average depth between the two ends to the nearest cm. The rate quoted shall be for a depth upto 1.5m or as given in the Schedule of Quantities.

2.1.2 Payment for trenches more than 1.5m in depth shall be made separately and as given in Schedule of Quantities.

2.2 **Refilling, Consolidation and Disposal of Surplus Earth**

Rate quoted for excavation of trenches shall be inclusive of refilling, consolidation and disposal of surplus earth within a lead of 50m. No separate payment for refilling shall be made.

SECTION – IV WATER SUPPLY SYSTEM

SCOPE OF WORK

1.1 Work under this section consists of furnishing all labor, materials equipment and appliances necessary and required to completely install the water supply system as required by the drawings, specified hereinafter and given in the Schedule of Quantities.

1.2 Without restricting to the generality of the foregoing, the water supply system shall include the following:-

a) All water lines to different parts of building and making connection from source etc.
b) Pipe protection and painting.
c) Providing Hot water supply lines and insulation of hot water pipe lines.
d) Control valves, masonry chambers and other appurtenances.
e) Connections to all toilets, kitchen equipment's, storage tanks and appliances.
f) Excavation and refilling of pipe trenches, wherever required.
g) Trenches for taking pipe lines for these services.

2. GENERAL REQUIREMENTS

2.1 All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Engineer-in-Charge / Owner.

2.2 Pipes and Fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

2.3 Short or Long bends shall be used on all main pipe lines as far as possible. Use of Elbows shall be restricted for short connections. As far as possible all Bends shall be formed by means of a hydraulic pipe bending machine for pipes up to 65mm dia.

2.4 Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

2.5 Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.

2.6 Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

3. uPVC PIPES

3.1 Definition

uPVC pipe means unplasticized Polyvinyl Chloride pipe.
It has density of Approx. 1.43 g / Cm3 as such it is less than $1/6^{th}$ the weight of C.I. and steel pipes, therefore easier to handle during installation and transportation.

3.2 The uPVC Pipes to be used for Portable water to be odorless and hygienic, and should have inside surface mirror smooth.

3.3 The Pipes should have high corrosion resistance and should be immune to chemical electrolytic and galvanic action.

3.4 These Pipes should be longer lasting because of corrosion resistance property.

3.5 **Handling Guidelines**

Pipes should be kept on an even surface while storing. They should be properly supported and should not be stacked for heights more then 1.5 meters for longer duration.

3.6 **Jointing Instructions**

The uPVC Pipes are of two types i.e., Selfit and Ringfit. The following procedure may be adopted while jointing the Pipes: -

(a) **Selfit Pipes**

- Cut the Pipes as square as possible and ensure fitment of Pipes with socket of fitting is correct. Total length of insertion of sockets to be marked from the Pipe.
- The Pipe and the socket should be clean and dry. Dust, Oil, water, grease etc. should be wiped out with dry cloth or cleaner from the surfaces to be coated with Solvent Cement.
- Roughen the outside of Pipe and inside of Socket using sand Paper up to the entry mark. Stir adhesive i.e. Solvent Cement thoroughly.
- Apply thick coat of Solvent Cement using a flat clean brush evenly on the inside of the socket mouth for full length of insertion and then outside of the Pipe end up to the marked line.
- After application of Solvent Cement, insert the Pipe within one minute in to the Socket. Hold the Joint for few seconds and ensure that the Pipe does not come out of the fittings. Wipe off extra cement and allow it to dry for at least 24 Hours. The PVC Pipe with joint is ready for use.

Consumption of Solvent Cement

Diameter of Pipe (mm)	20	25	32	40	50	63	75	90	110	160	200	250	315	400
Approx. No: of joints which can be made per liter of Solvent cement	324	270	225	180	130	125	103	79	54	27	15	9	5	2

(b) **Ring-fit Pi**

- Clean the inside of Socket. Remove all traces of mud, dirt, grease, gravel and also clean sealing ring.

- Form the EPDM ring into heart shape by pinching a portion of ring inside. Insert it into the socket and release to seat in to the groove.

- Mark the insertion depth on spigot portion of the pipe. Clean and apply lubricant to insertion depth before pushing in to the Socket. Ensure that no sand or dirt adheres to the lubricated surface of the Pipe.

- Push the Spigot into the Socket until it reaches the depth of entry mark, taking care not to over insert. This can be done manually. Make sure that the insertion of Spigot end inside the socket should be at correct angle. The Pipe and Joint are ready for use.

- In case of large diameter Pipes if crow bar does not give sufficient leverage, use of jointing jack may be helpful.

Precautions

1. uPVC Pipes and Fittings should not be cleaned by Solvent Cement.
2. For large diameter and Higher-class Pipes (6 kgf/cm^2 & above), use heavy duty Solvent cement.
3. uPVC pipes and fittings to be used of same Brand and Manufacturer.

4. CPVC PIPES AND FITTINGS

4.1 Description

CPVC piping shall be Fire Proof, Corrosion resistance with smooth, friction free interior surfaces and with anti - bacterial growth properties.

4.2 JOINING TUBING & FITTINGS

(a) **Cutting**

CPVC tubing shall be cut with a wheel-type plastic tubing cutter, a hack saw or other fine-toothed hand or power saws. Use of ratchet cutters shall be permitted, provided blades are sharpened regularly. A milter box should be used to ensure a square cut when using a saw.

(b) **Deburring/Beveling**

Burrs and fillings can prevent proper contact between tube and fitting during assembly, and should be removed from the outside and inside of the tubing. A chamfering tool shall be used for this purpose. A slight bevel on the end of the tubing shall be provided to enable entry of the tubing into the fitting socket and minimize the chances of pushing solvent cement to the bottom of the joint.

(c) **Fitting Preparation**

The surfaces shall be wiped clean of dirt and moisture from the fitting sockets and tubing end. Check the dry fit of the tubing and fitting. The tubing should make contact with the socket wall 1/3 to 2/3 of the way into the fitting socket.

(d) **Solvent Cement Application**

Only approved type Solvent Cement shall used for jointing the CPVC pipes, which shall be procured as per the manufacturer recommendations. Apply an even coat of Cement Solvent on the Pipe end after cleaning of whole pipe and also inside the fittings socket. Old or deteriorated or thickened or Lumpy Solvent Cement shall not be used.

(e) **Assembly**

Immediately insert the pipe into fitting socket, rotate the pipe ¼ to ½ turn while inserting. This motion ensures an even distribution of cement within the joint. Properly align the fitting. Hold the assembly for approximately 10 seconds, allowing the joint to set-up. An even bead of cement should be evident around the socket edge, it may indicate that sufficient cement was applied. In this case, remake the joint to avoid potential leaks. Wipe excess cement from the tubing and fitting surfaces for an attractive, professional appearance.

(f) **Rating & Dimensional Details of CPVC Pipes SDR 11**

Nominal Pipe Size		Average Outside Diameter		Wall Thickness		Pressure Rating	
inch	mm	inch	mm	inch	mm	73.4° F psi	23° C kg/cm²
½	12.70	0.625	(15.9)	0.068	(1.73)	400	28
¾	19.05	0.875	(22.2)	0.080	(2.03)	400	28
1	25.40	1.125	(28.6)	0.102	(2.59)	400	28
1 ¼	31.75	1.375	(34.9)	0.125	(3.18)	400	28
1 ½	38.10	1.625	(41.3)	0.148	(3.76)	400	28
2	50.80	2.215	(54.0)	0.193	(4.90)	400	28

5. **G.I. PIPES & FITTINGS**

5.1 All pipes inside the buildings and where specified, outside the building shall be galvanized steel tubes. When class is not specified, they shall be medium class.

5.2 Fittings shall be malleable iron galvanized fittings, of approved make. All fittings shall have manufacturer's trade mark stamped on it. Fittings for G.I. pipes shall include Couplings, Bends, Tees, Reducers, Nipples, Unions, Bushes etc.

5.3 Pipes and fittings shall be jointed with screwed fittings. Care shall be taken to remove burr from the end of the pipe after cutting by a round file. Genuine red lead with grummet and a few strands of fine hemp shall be applied. All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. G.I. pipes inside toilets shall be fixed in wall chases well above the floor. No pipes shall be run inside a sunken floor as far as possible. Pipes may be run under the ceiling or floors and other as shown on drawings.

6. HIGH DENSITY POLYTHENE PIPES

6.1 High Density Polythene Pipe (HDPE) for Water Supply shall be with pressure rating PN 10 or as specified in bill of Qty.

6.2 Laying and Jointing of HDPE Pipes

Laying and jointing of the pipes shall be done as per BSI/NBS.

While laying the pipe in trenches the bed of the trench should be level and free from sharp edged stones. While laying in rocky areas suitable bed of sand or gravel should be provided. The initial back fill about 10 to 15 cm above the pipe should be fine sand or screened excavated material. Where hard rock is met with, bed concrete M-100, 15 cm shall be provided, before putting in the soft sand/gravel.

Jointing of two pipes shall be done through Butt-Welding. The method of butt-welding shall be as below:

a) The ends of the pipes to be joined are cut vertically at right angles with a fine-toothed saw and trimmed with a file to make both ends smooth so that the pipes when pressed together are without leaving any gap.
b) Both the inside and outside surfaces of the ends of the pipes are scraped (up to about ½" from the end) with a sharp scraper to remove the thin oxidized layer.
c) It is necessary to see that there are no extraneous particles of dust, mud, grease, polyethylene powder etc. at the joining portion of the pipes.

An electrical HEAT MIRROR (Hot Plate) is used for heating the ends of the pipes. The pipes are pressed flush against the flat surface of the Heat Mirror, one on each side horizontally, and held in that position under slight pressure. The Heat Mirror is maintained at a steady temperature of 200 deg C. with the help of THERMOSTAT. After a while, a slight rim is formed at the ends of the pipes both inside and outside. When a rim of about 1/10" to 1/8" is formed, the pipes are pulled apart and the Heat Mirror is quickly withdrawn. Then the two ends of the pipes are brought together face to face so that the molten portions come into contact with each other. Then the pipes are drawn back very slightly (without separating the joined molten portion) and then again, the pipes are pressed together with a moderate pressure of about (1 to 1.5 kg/cm sq). This ensures that any air bubbles are squeezed out. The pipes are held in that position until the pipe-joint cools off naturally in atmospheric air. When a perfect joint is made, the rims cohere in such a way that there is only a very fine slight depression between the two rims. If the top surface of the rim is too flat, it will be because the pipe is overheated. If there is too much of depression (groove) between the rims, the pipe is under-heated. The rims should not be cut off or erased from the joints. Also, correct alignment of the pipes will help in joining the pipes perfectly, as otherwise there will be reduction in the area of the joining surface rendering the joint weak and imperfect.

7. CLAMPS

G.I. pipes in shafts and other locations shall be supported by M.S. clamps of design approved by Engineer-in-Charge / Owner. Pipe in wall chases shall be anchored by iron hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from M.S. structural as described in the sub section. Pipes in typical shafts shall be supported on Slotted Angles/Channels as specified elsewhere.

8. **UNIONS**

Contractor shall provide adequate number of unions on all pipes to enable dismantling later. Unions shall be provided near each Gunmetal Valve, Stop Cocks, or Check Valves and on straight runs as necessary at appropriate locations as required and/or directed by Engineer-in-Charge / Owner.

9. **FLANGES**

Flanged connections shall be provided on pipes where shown on the drawings, all equipment connections as necessary and required or as directed by Engineer-in-Charge / Owner. Connections shall be made by the correct number and size of the bolts and made with 3 mm thick insertion rubber washer. Where hot water or steam connections are made insertion gasket shall be of suitable high temperature grade and quality approved by Engineer-in-Charge / Owner. Bolt hole dia for flanges shall conform to match the specification for C.I. Sluice Valve.

10. **TRENCHES**

The galvanized iron pipes and fittings shall be laid in trenches. The width and depth of the trenches for the different diameters of the pipes shall be as follows:

Dia of Pipe	Width of Trench	Depth of Trench
15mm to 50mm	30 cms	60 cms
65mm to 100mm	45 cms	75 cms

At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for earthwork in trenches.

When excavation is done in rock, it shall be cut deep enough to permit the pipes to be laid on a cushion of sand minimum 7.5 cm deep.

11. **PAINTING**

11.1 All surfaces shall be thoroughly cleaned before painting.

11.2 All pipes above ground shall be painted with one coat of Red Lead and two coats of Synthetic Enamel paint of approved shade and quality. Pipes shall be painted to standard color code specified by Engineer-in-Charge/Owner.

11.3 All pipes in chases and below floor shall be provided Anti-corrosive treatment.

12. **PIPE PROTECTION**

Where specified in the Schedule of Quantities all pipes below ground shall be protected against corrosion by wrapping 100mm wide and 4mm thick layer of material of approved make over the pipe.

13. **GUNMETAL VALVES**

13.1 Valves 65mm dia and below shall be heavy Gunmetal Fullway Valves or Globe Valves or Ball valves conforming to I.S. 778-1971 of 20 Kg/cm^2 class. Valves shall be tested at manufacturer's works and the same stamped on it.

13.2 All Valves shall be approved by the Engineer-in-Charge / Owner before they are allowed to be used on work.

14 BALL VALVES

Ball Valves have body material as Forged Brass Chrome plated with Spindle Brass Nickel Plating & Lever handle Steel Chrome plated with green plastic cover. The valve is suitable for water maximum working pressure up to 25 bar (PN 25). The valve is operated by turning. The rotation from open to close is a quarter turn (90^{o}) which closes in a clock-wise direction.

15. BUTTERFLY VALVES

a) Butterfly valves of approved quality for pressure rating of 230 P.S.I. with locking arrangement and gearbox with handle operated or gearbox with lid shall be provided or as given in the Bill of Quantities.

b) Butterfly valves shall be of specified quality.

c) Joints for butterfly valves shall be made with suitable tail /socket pieces on the pipe line and flanged joints made with 3mm thick insertion rubber gasket with appropriate number of bolts, nuts and washers.

d) Butterfly valves shall be provided on all branches as shown in the drawings or as specified.

16. SLUICE VALVES

16.1 All valves 80mm dia and above shall be C.I. Double Flanged Sluice Valves. Sluice valves shall be Cast Iron double flanged, with rising spindle. Each sluice valve shall be provided with wheel for valves in exposed positions and Cap Top for underground valves. Contractor shall provide suitable operating keys for Sluice Valves with Cap Tops.

16.2 Sluice valves shall be of best quality of class specified.

16.3 Sluice valves shall be socketed type or double flanged type.

a) Joints for socketed valves shall be lead-caulked joints as specified above.

b) Joints for double flanged sluice valves shall be made with suitable tail/socket pieces on the pipeline and flanges joints made with 3 mm thick insertion rubber gasket with appropriate number of bolts, nuts and washers.

c) Sluice valves shall be installed at all branches and as shown on the drawings.

17. SCOUR VALVES

Scour valves shall be C.I. sluice valves as specified above. They shall be installed at the lowest level or tail end of the system as shown on drawings and directed by Engineer-in-Charge / Owner.

18. **AIR RELEASE VALVES**

a) Air release valves shall be single acting type air valves with cast iron body and bronze/gunmetal internal parts and plastic float.

b) Each air release valve shall be provided with a cast iron isolating sluice valve of specification given above.

19. **INSULATION**

The insulation for hot water pipes shall be done as specified in Bill of Quantities and accordingly following guidelines shall be followed:

19.1 **For Chased Internal Pipes**

Hot water pipes fixed in chase shall be insulated by wrapping 6 mm thick thermal insulation tubbing's or Ceramic Rope made up of Ceramic fiber's laid parallel to each other with stainless steel wire wrapped around for reinforcing the fibre complete as per requirement and finishing it with 6mm rough cement plaster 1:3 mixed with Rapid Hardening Cement.

19.2 **For External Piping**

External hot water line laid in trenches, exposed in shafts, on terrace and along ceiling level shall be insulated with either thermal tubbing's of specified thickness or fibre glass wool blankets/mats, as specified in Bill of Quantities. After the insulation, all the pipes shall be protected with either 12mm thick smooth finished cement plaster (two layers of 6 mm thick of mix 1:2 Portland cement and fine sand) or they shall be cladded with 24 SWG aluminum sheet as specified in Bill of Quantities.

19.3 The specifications of the material shall be generally as follows, unless specified:

a)	Fibre glass wool	--	Blankets/mats of 50 mm thickness in the density of 24 kg/m^3
b)	Elastomeric Flexible Material	--	Thermal Insulation tubbing's of 6mm thickness with density of 60-90 Kg/m3.

19.4 Generally, following procedure shall be adopted:

(i) Cleaning the pipe surface to be insulated to make it free from dust &oil.

(ii) Applying a layer of zinc chromate/anti-rust Japanese primer.

(iii) Fixing fibre glass wool blankets or mats/Elastomeric Flexible Tubing's as specified.

(iv) Covering it all-round with 24 gauge wire netting with proper butt joint and tightly wrapped.

(v) Applying two layers of 6 mm thick each cement plaster in the ratio of 1:2 (1 cement: 2 fine sand).

(vi) Applying weather proofing coating of Insulkote OR of approved material over the cement plaster.

(vii) For certain places, where exposed insulation is not to be plastered as specified in item (v) and (vi), then aluminum foil sheet of 24 gauge with 50 mm overlapping, fixed with self-tapping recessed screwed shall be provided.

20. CAST IRON PIPES

20.1 Pipes for water supply mains where specified shall be cast iron pipes, centrifugally cast spun iron pipes, class LA BSI/NBS. Quality certificates shall be furnished.

20.2 Fittings and Inspection Chambers

Fittings and chambers shall be provided as required.

20.3 Anchor Block

Suitable anchor blocks shall be provided at all bends and tees to encounter the excessive thrust developed due to water hammer.

20.4 Rubber Joints

Joints between two pipes shall be made by premoulded rubber joints with suitable tackles in a manner recommended & approved by the manufacturer. No joints shall be covered until the lines are Hydraulically tested.

21. VALVE CHAMBERS

21.1 Contractor shall construct chambers for all full way valves, butterfly valves and other type of valves as specified in the Bill of Quantities. These shall be made, in brick masonry in cement mortar 1:4 (1 cement: 4 coarse sand) on cement concrete foundations 150mm thick 1:5:10 mix (1 cement: 5 coarse sand: 10 graded stone aggregate 40mm nominal size) 12 mm thick cement plaster 1:3(1 cement : 3 coarse sand) inside finished with a floating coat of neat cement with 8mm thick M.S surface box with hinged cover and locking arrangement, 150 mm thick reinforcement cement concrete top slab of 1:2:4 (1 cement : 2 coarse sand: 4 graded stone aggregate 20mm nominal size), as specified and shown in drawings, including excavation, back filling rammed complete or as specified in Bill of Quantities.

21.2 Valve chambers shall be constructed as specified in BOQ but generally shall be of following sizes:

	Length (mm)	Width (mm)	Depth (mm)
For pipes dia. Up to 80 mm	600	600	1000
For pipes dia. 80 mm and above	750	750	1000

22. TESTING

22.1 All pipes, fittings and valves shall be tested by hydrostatic pressure of min. 1.5 times, the working pressure and subject to minimum of 7 kg/cm^2 in any case and with the consent of Engineer-in-Charge / Owner.

Pressure shall be maintained for a period of at least two hours without appreciable drop in the pressure after fixing at site. ($\pm$10 %). A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and Engineer.

22.2 In addition to the sectional testing carried out during the construction, Contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakages, and shall replace all defective materials in the system. Any damage done due to carelessness, open or burst pipes or failure of fittings, to the building, furniture and Fixtures shall be made good during the defects liability period without any extra cost.

22.3 After completion of the water supply system, Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which do not effectively operate shall be replaced by new ones at no extra cost and the same shall be tested as above.

23. MEASUREMENT

23.1 Pipes

Pipes shall be measured per linear meter (to the nearest cm) and shall be inclusive of all fittings e.g. couplings, tees, bends, elbows, unions, deduction for valves shall be made, cutting holes chases and making good the same and all items mentioned in the specifications and Schedule of Quantities.

(a) Gunmetal and cast-iron valves shall be measured by numbers.

(b) Single flanges shall be measured by numbers (per single flange) and shall include bolts, nuts, washers and 3mm thick rubber gasket complete.

(c) Pair of flanges shall be measured by number of pairs and shall include bolts, nuts, washers, and 3 mm thick rubber gaskets complete.

23.2 Insulation

Insulation for hot water pipes shall be measured per linear metre (to the nearest cm) along the centre line of pipe and shall be measured over all fittings and flanges. No separate or additional payment shall be made for insulation of Bends, Tees, Flanges or Other Fittings and Valves. The rate shall include all items specified in the Schedule of Quantities and given in the specifications.

Aluminum cladding/Plaster over the insulated pipes shall be measured by square metre area of the finished surface. The rate shall be inclusive of all items given in the Schedule of Quantities.

23.3 Painting

Painting for Pipes and over insulation shall be measured per linear metre over finished surface and shall include all valves and fittings for which no deduction shall be made.

24. DISINFECTION

24.1 After completion of the work Contractor shall flush clean the entire system with the city's filtered water after connection has been made.

24.2 After the first flushing, commercial bleaching powder is to be added to achieve a dosage of 2 to 3 mg/l of water in the system added and flushed. This operation should be performed twice to ensure that the system is fully disinfected and usable.

25. **PRE-COMMISSIONING**

25.1 Ensure that all pipes are free from debris and obstructions.

25.2 Check all valves effective opening and closing action. Defects should be rectified or valves replaced.

25.3 Ensure that all Connections to Branches has been made.

25.4 Ensure that mains have been connected to the respective pumps, underground and overhead tanks.

25.5 Water supply should be available at main Underground tank.

25.6 All main line Valves should be closed.

26. **COMMISSIONING**

26.1 Fill Underground tank with water. Add 1kg fresh bleaching powder after making a solution to be added near inlet.

26.2 Start Water Supply Pump and allow water to fill main Underground tank. Water will first fill the water tank and then overflow to the Raw Water tanks.

26.3 After filling Overhead Reservoir drain the same to its one forth capacity through tank scour valve. (This is to ensure removal of all mud, debris etc. from the tank).

26.4 Fill Overhead tank to full.

26.5 Release water in the main lines by opening Valves in each circuit. Drain out water in the system through scour valves. Ensure clean water is now coming out of the system.

26.6 Open valves for individual clusters. Observe for leakages or malfunctions, check pressure & flow at end of line by opening Hydrants etc. Remove and rectify defects noticed.

26.7 Check all outlet points for proper operation by opening each valve and allowing water to flow for a few minutes. Also check for effective closure of valve.

26.8 The entire water supply system should be disinfected with bleaching powder and system flush cleaned.

26.9 Send four samples of water drawn from four extreme locations for testing for bacteriological test in sterilized bottles obtained from the concerned laboratory. (Laboratory personal may collect the samples themselves).

27. **RESPONSIBILITY**

Responsibility for various activities in pre-commissioning and commissioning procedures will rest with the Contractor.

END OF SECTION – IV

SECTION - V SEWERAGE / DRAINAGE SYSTEM

1.0 SCOPE OF WORK

1.1 Work under this section shall consist of furnishing all Labour, Materials, Equipments and Appliances necessary and required to completely finish Sewerage/Drainage system as required by the drawings and specified hereinafter or given in the Schedule of Quantities.

1.2 Without restricting to the generality of the foregoing, the sewerage system shall include:

a) Internal/External sewer line.

b) Excavations including refilling etc.

c) Construction of Collection Chambers, Manholes and Drop Connections.

d) Storm Water Drainage, Harvesting and Disposal

2.0 GENERAL REQUIREMENTS

2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of the Engineer-in-Charge.

2.2 Drainage lines shall be laid to the required gradients and profiles.

2.3 All drainage work shall be done in accordance with the local Municipal byelaws.

2.4 Contractor shall obtain necessary approval and permission for the Drawing system from the Municipal or any other competent authorities.

2.5 Location of all manholes, catch basins etc., shall be got confirmed from the Contractor from the Engineer-in-Charge before the actual execution of work at site.

2.6 All works shall be executed as directed by Engineer-in-Charge.

3.0 ALIGNMENT AND GRADE

The sewer pipes shall be laid to alignment and gradient shown on the drawings but subject to such modifications as shall be ordered by the Engineer-in-Charge from time to time to meet the requirements of the works. No deviations from the lines, depths of cutting or gradients of sewers shown on the plans and sections shall be permitted except by the express direction in writing of the Engineer-in-Charge.

4.0 REINFORCED CEMENT CONCRETE PIPES

4.1 All underground storm water drainage pipes and sewer lines where specified (other than those specified cast iron) shall be centrifugally spun RCC pipes of specified class. Pipes shall be true and straight with uniform bore, throughout Cracked, warped pipes shall not be used on the work. All pipes shall be tested by the manufacturer and the Contractor shall produce, when directed a certificate to that effect from the manufacturer confirming to BSI/NBS.

4.2 **Laying**

R.C.C. spun pipes shall be laid on cement concrete bed or cradles as specified and shown on the detailed drawings. The cradles may be precast and sufficiently cured to prevent cracks and breakage in handling. The invert of the cradles shall be left 12mm below the invert level of the pipe and properly placed on the soil to prevent any disturbance. The pipe shall than be placed on the bed concrete or cradles and set for the line and gradient by means of sight rails and boring rods etc. cradles or concrete bed may be omitted, if directed by the Project Manager.

4.3 **Jointing**

After setting out the pipes the collars shall be centered over the joint and filled in with tarred gaskin, so that sufficient space is left on either side of the collar to receive the mortar. The space shall then be filled with cement mortar 1:2 (1 cement: 2 fine sand) and caulked by means of proper tools. All joints shall be finished at an angle of 45 degree to the longitudinal axis of the pipe on both side of the collars neatly.

5.0 **SALT GLAZED STONEWARE PIPES**

5.1 Stoneware pipes shall be of first-class quality salt glazed and free from rough texture inside or outside and straight. All pipes shall have the manufacturers name marked on it and shall comply to BSI/NBS and shall be of approved makes.

5.2 **Laying and Jointing of Stoneware Salt Glazed Pipes**

a) Pipes are liable to be damaged in transit and notwithstanding tests that may have been made before dispatch each pipe shall be examined carefully on arrival at site. Each pipe shall be rung with a wooden hammer or mallet and those that do not ring true and clear shall be rejected. Sound pipes shall be carefully stacked to prevent damage. All defective pipes should be segregated, marked in a conspicuous manner and their use in the works prevented.

b) The pipes shall be laid with sockets leading uphill and should rest on solid and even foundations for the full length of the barrel. Socket holes shall be formed in the foundation sufficiently deep to allow the pipe jointer room to work right round the pipe and as short as practicable to admit the socket and allow the joint to be made.

c) Where pipes are not bedded on concrete the trench bottom shall be left slightly high and carefully bottomed up as pipe laying proceeds so that the pipe barrels rest on firm ground. If excavation has been carried too low it shall be made up with cement concrete 1:5:10 mix at the Contractor's cost and charges.

d) If the bottom of the trench consists of rock or very hard ground that cannot be easily excavated to a smooth surface, the pipes shall be laid on cement concrete bed of 1:5:10 mix to ensure even bearing.

5.3 **Jointing of Pipes**

a) Tarred gaskin shall first be wrapped round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid, the pipe shall then be adjusted and fixed in its correct position and the gaskin caulked tightly home so as to fill not more than one quarter of the total length of the socket.

b) The remainder of the socket shall be filled with stiff mix of cement mortar (1 cement: 1 clear sharp washed sand). When the socket is filled, a fillet should be formed round the joint with a trowel forming an angle of 45 degrees with the barrel of the pipe. The mortar shall be beaten up and used after it has begun to set.

c) After the joint has been made any extraneous materials shall be removed from inside of the joint with a suitable scraper or "Badger". The newly made joints shall be protected until set from the sun, drying winds, rain or dust. Sacking or other materials, which can be kept damp, shall be used. The joints shall be exposed and space left all rounds the pipes for inspection by the Engineer-in-Charge. The inside of the sewer must be left absolutely clear in bore and free from cement mortar or other obstructions throughout its entire length, and shall efficiently drain and discharge.

6.0 GULLY TRAPS

6.1 Gully traps shall be of the same quality as described for stoneware pipes in Clause 6.

6.2 Gully traps shall be fixed in cement concrete 1:5:10 mix (1 cement: 5 coarse sand: 10 stone aggregate 40mm nominal size) and a brick masonry chamber 30x30 cms inside in cement mortar 1:3 with 10 x 10 cms grating inside and 30x30 cms C.I. sealed cover and frame weighting not less than 7.2 kg to be constructed as per standard drawing. Where necessary, sealed cover shall be replaced with C.I. grating of the same size.

7.0 GREASE TRAP

Grease Trap shall be provided on Kitchen waste lines before discharging the waste into the main sewer line. Grease Trap shall be built in brick masonry and shall be similar in construction to manholes. The grease trap shall be construction to size as shown at the location on drawings. The grease trap shall be provided with drop inlet, drop outlet, galvanised wrought iron sediment pan and a baffle wall. Grease trap shall be provided with 2 Nos, double seal manhole cover and frame which shall be identified with lettering `Grease trap".

7.0 CAST IRON PIPES FOR DRAINAGE

7.1 All drainage lines passing under building, floors and roads with heavy traffic, in exposed position above ground e.g. service floor and basement ceiling shall be Cast Iron pipes Class LA. Position of such pipes shall generally be shown on the drawings.

7.2 Cast iron pipes shall be centrifugally spun iron pipes. Quality certificates shall be furnished.

7.3 Fittings and Inspection Chambers

a) Fittings used for C.I. drainage pipe shall conform to BSI/NBS. Wherever possible junction from branch pipes shall be made by a 'Y tee'.

b) Cleanout plugs shall be provided on head of each drain and at location indicated on plans or directed by Engineer-in-Charge. Cleanout plugs shall be of size matching the full bore of the pipe. Plugs shall be made out with G.I. coupling caulked into the socket of the pipe or fittings. The end shall be provided with a brass screwed plug with suitable key for opening.

7.4 **Laying**

a) All cast iron pipes and fittings shall be jointed with best quality soft Pig Lead which shall be free from impurities. In wet trenches joints shall be made from Lead Wool. Nothing extra will be paid for Lead Wool joints. Depth of pig lead and weight for joints shall be as given in BSI.

b) The spigot of pipe or fittings shall be centered in the adjoining socket by caulking. Sufficient turns of tarred gaskin to leave unfilled the required depth of socket for depth of 45mm when the gaskin has been caulked tightly home. Jointing ring shall be placed round the barrel and against the face of the socket. Molten Pig Lead shall then be poured to fill the remainder of the socket. This shall then be done in one pouring. The lead shall then be solidly caulked with suitable tools and hammers weighting not less than 2 kg.

c) For lead wool joints the socket shall be caulked with tarred gaskin, as explained above. The lead wool shall be inserted into the sockets and tightly caulked home skein by skein with suitable tools and hammers of not less than 2 kg weight until joint is filled.

7.5 **Testing**

a) All lengths of the sewer and drain shall be fully tested for water tightness by means of water pressure maintained for not less than 30 minutes. Testing shall be carried out from manhole. All pipes shall be subjected to a test pressure of at least 1.5 metre head of water. The test pressure shall, however, not exceed 1.5 metre head at any point. The pipes shall be plugged preferably with standard design rubber plugs on both ends. The upper end shall, however, be connected to a pipe for filling with water and getting the required head. The tolerance figure of two liters per centimeter of dia per kilometer may be allowed during a period of ten minutes. Subsidence of the test water may be due to one or more of the following causes.

   (i) Absorption by pipes and joints

   (ii) Sweating of pipe or joints

   (iii) Leakage at joints or from defective pipes

b) Trapped Air

   Allowance shall be made for (i) by adding water until absorption has ceased after which the test proper should commence. Any leakage will be visible and the defective part of the work should be cut out and made good. A slight amount of sweating which is uniform may be overlooked, but excessive sweating from a particular pipe or joint shall be watched for and taken as indicating a defect to be made good.

c) Sewer and Drain Pipelines shall be tested for straightness by:

   (i) Inserting a smooth ball 12mm less than the internal diameter of the pipe. In the absence of obstructions such as yarn or mortar projecting at the joints the ball should roll down the invent of the pipe and emerge at the lower end.

   (ii) Means of a mirror at one end and a lamp at the other end. If the pipe line is straight the full circle of light will be seen otherwise obstruction of deviation will be apparent.

d) The Contractor shall give a smoke test to the drains and sewer at his own expense and charges, if directed by the Engineer-in-Charge.

e) A test register shall be maintained which shall be signed and dated by Contractor, Engineer-in-Charge and representative of Architects/ Consultants.

8.0 CEMENT CONCRETE AND MASONRY WORKS FOR MANHOLES AND CHAMBERS ETC.

8.1 Materials

a) **Water**
Water used for all the construction purposes shall be clear and free from Oil, Acid, Alkali, Organic and other harmful matters, which shall deteriorate the strength and/or durability of the structure. In general, the water suitable for drinking purposes shall be considered good enough for construction purpose.

b) **Aggregate for Concrete**
The aggregate for concrete shall be in accordance with BSI/NBS in general, these shall be free from all impurities that may cause corrosion of the reinforcement. Before actual use these shall be washed in water, if required as per the direction of Engineer-in-Charge.

c) **Sand**
Sand for various constructional purposes shall comply in all respects with BSI/NBS. It shall be clean, coarse hard and strong, sharp, durable, uncoated, free from any mixture of clay, dust, vegetable matters, mica, iron impurities soft or flaky and elongated particles, alkali, organic matters, salt, loam and other impurities which may be considered by the Engineer-in-Charge as harmful for the construction.

d) **Cement**
The cement used for all the constructional purposes shall be ordinary Portland cement or rapid hardening Portland cement.

e) **Mild Steel Reinforcement**
The mild steel for the reinforcement bars shall be in the form of round bars conforming to all requirements of Codes.

f) **Bricks**
Bricks shall have uniform colour, thoroughly burnt but not over burnt, shall have plan rectangular faces with parallel sides and sharp right-angled edges. They should give ringing sound when struck. Brick shall not absorb more than 20% to 22% of water, when immersed in water for 24 hours. Bricks to be used shall be approved by the Engineer-in-Charge.

g) **Other Materials**
Other materials not fully specified in these specifications and which may be required in the work shall conform to the latest I.S. All such materials shall be approved by the Engineer-in-Charge before use.

8.2 Cement Concrete (Plain or Reinforced)

a) Cement concrete pipes bedding, cradles, foundations and RCC slabs for all works shall be mixed by a Mechanical mixer where quantities of the concrete poured at one time

permit. Hand mixing on properly constructed platforms may be allowed for small quantities by the Engineer-in-Charge. Rate for cement concrete shall be inclusive of all shuttering and centering at all depth and heights.

b) Concrete work shall be of such thickness and mix as given in the Schedule of Quantities.

c) All concrete work shall be cured for a period of at least 7 days. Such work shall be kept moist by means of gunny bass at all times. All pipe trenches and foundations shall be kept dry during the curing period.

8.3 **Masonry Work**

Masonry work for manholes, chambers, brick masonry pipe trench and such other works as required shall be constructed from 1st class bricks or 2nd class as specified in the Schedule of Quantities in cement mortar 1:5 mix (1 cement: 5 coarse sand). All joints shall be properly raked to receive plaster.

8.4 **Cement Concrete for Pipe Support**

a) Wherever specified or shown on the drawings, all pipes shall be supported in concrete bed all round or in haunches. The thickness and mix of the concrete shall be given in the Schedule of Quantities. Type of the bedding is as described as follows:

b) Unless otherwise directed by the Engineer-in-Charge cement concrete for bed, all round or in haunches shall be laid as follows:-

Description	Upto 3 M depth
Pipes in open ground (No sub soil water)	All round (1:4:8)
Pipes (all) in sub soil water condition	All round (1:3:6)
Pipes under the building or at road crossing or under public places	All round (1:2:4)

(1=1 cement, 2-4=coarse sand, 4-8 stone aggregate 20 / 40mm nominal size)

c) R.C.C. pipes or C.I. pipes ,may be supported on brick masonry or precast R.C.C or Cast insitu cradles. Cradles shall be as shown on the drawings.

d) Pipes in loose soil or above ground shall be supported on brick or RCC anchor blocks as shown on the drawings.

9.0 **MANHOLES AND CHAMBERS**

9.1 All manholes, chambers and other such works as specified shall be constructed in brick masonry in cement mortar 1:5 (1 cement: 5 coarse sand) or as specified in the Schedule of Quantities.

9.2 All Manholes, Chambers, etc., shall be supported on base of cement concrete of such thickness and mix as given in the Schedule of Quantities or shown on the drawings.

Where not specified, Manholes may be constructed as follows:-

(All dimensions internal clear in cms)

Size of Manhole Type	90x80 Rect.	120x90 Rect.	91 dia Circular	122 dia Circular	140 dia Circular
Maximum depth	120	245	170	245	Any depth beyond 245
Average thickness of R.C.C slab	15	15	--	--	--
Size of cover and frame (Internal dia in cms)	61x45.5	50 dia	56 dia	56 dia	56 dia
Weight of cover and frame	38 Kg. or as specified	116 Kg. or 170 Kg. or 208 Kg. or as specified in BOQ	116 Kg. or 170 Kg. or 208 Kg. or as specified in BOQ	116 Kg. or 170 Kg. or 208 Kg. or as specified in BOQ	116 Kg. or 170 Kg. or 208 Kg. or as specified in BOQ
Type of Cover & Frame	C.I	C.I. or SFRC as specified in BOQ.	C.I. or SFRC as specified in BOQ.	C.I. or SFRC as specified in BOQ.	C.I. or SFRC as specified in BOQ.

9.3 All manholes shall be provided with cement concrete benching in 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20mm nominal size). The benching shall have a slope of 10cm towards the channel. The depth of the channel shall be full diameter of the pipe. Benching shall be finished with a floating cost of neat cement.

9.4 All manholes shall be plastered with 12/15mm thick cement mortar 1:3 (1 cement: 3 coarse sand) and finished with a floating coat of neat cement inside. Manhole shall be plastered outside as above but with rough plaster.

9.5 All manholes with depths greater than 1 M. shall be provided with plastic encapsulated 20mm square or 25mm round rods foot rungs set in cement concrete blocks 25 x 10 x 10cms in 1:2:4 mix 30cms vertically and staggered. Foot rests shall be coated with coal tar before embedding.

9.6 All manholes shall be provided with cast iron covers and frames and embedded in reinforced cement concrete slab or SFRC precast concrete covers as per instructions of the Engineer-in-Charge. Weight of cover, frame and thickness of slab shall be as specified in the Schedule of Quantities or as given above.

9.7 All catch basins shall be having C.I. grating or SFRC precast Gully Grating as per instructions of Engineer-in-Charge. The grating along with frame shall be of approved design and quality as per instruction of Engineer-in-Charge.

10.0 **MAKING CONNECTIONS**

Contractor shall connect the new sewer line to the existing manhole by cutting the walls, benching and restoring them to the original condition. A new channel shall be cut in the benching of the existing manhole for the new connection. Contractor shall remove all sewage and water if encountered in making the connection without additional cost.

11.0 **MEASUREMENT**

11.1 **Stoneware Pipes/R.C.C. Pipes/C.I. Pipes**

Stoneware pipes/R.C.C. pipes/C.I. pipes shall be measured for the finished length of the pipe line per linear metre i.e. (a) lengths between Manholes shall be recorded from inside of one manhole to inside of other manhole, (b) length between socket of pipe near gully

trap and inside of manhole. Rate shall include all items given in the Schedule of Quantities and specifications.

11.2 **Gully Traps**

Gully traps shall be measured by the number and rate shall include all Excavation, Foundation, Concrete Brick Masonry, Cement Plaster inside and outside, C.I. Grating and sealed cover and frame.

11.3 **Manholes**

(a) All manholes shall be measured by numbers and shall include all items specified above under clause 1.2 and necessary Excavation, Refilling & Disposal of surplus earth.

(b) Manholes with depths greater than specified under the main item shall be paid for under "extra depth" and shall include all items as given for manholes. Measurement shall be done to the nearest cm. Depth of the manholes shall be measured from top of the manhole cover to bottom of Channel.

11.4 **Drop Connections**

Drop connections shall be measured by number for a depth of 60 cms or part thereof between invert levels. Additional depth shall be paid for as extra per metre depth as per the actual length of the drop connection, measured to the nearest cm.

11.5 **Making Connections**

Item for making connection to municipal sewer shall be paid for by number and shall include all items given in the Schedule of Quantities and Specifications.

11.6 **Masonry Drains**

Payment for masonry drains shall be made under individual items of Masonry, Cement concrete and plaster by volume or area as given in the Schedule of Quantities.

11.7 Brick Masonry and Cement Concrete shall be measured per cubic metre and shall include all items as given in the Schedule of Quantities.

11.8 Cement Plaster shall be measured per square metre area.

SECTION - VI WATER SUPPLY PUMPS AND WATER TREATMENT PLANT

1.1 Work under this sub-head consists of furnishing all labour, materials, equipment and accessories necessary and required to completely install pumping system for various water supply services and water treatment as per drawings, specified hereinafter and given in the Bill of Quantities.

1.2 Without restricting to the generality of the foregoing, the work of pumps and water treatment equipment shall include the followings:

a) Raw water pumps.

b) Hydro pneumatic Water Pump sets for Domestic water supply.

c) Soft water Pumps.

d) Garden Hydrant Pumps.

e) Sump pumps for disposal of sewage and drainage.

f) Water treatment unit consisting of filter, softener and chlorination etc.

g) Electrical panels, power and control cabling and allied electrical works.

h) Level Controller & Indication System.

i) Pipes, valves, accessories, hangers, supports, delivery and suction feeders and connection to proposed pipe work.

j) Reverse Osmosis Plant.

2.0 PUMP SET

2.1 Water Supply Pumps

(These specifications are applicable for all clear water pumps and as specified in Bill of Quantities)

2.1.1 Water supply pumps shall be suitable for clean water. Pumps shall be single or multistage, monoblock horizontal, vertical, centrifugal pumps with cast iron/stainless steel body and stainless steel/bronze impeller, stainless steel shaft and coupled to a TEFC electric motor by means of a flexible coupling or as specified in bill of quantities. Each pump should operate at a curve 10m below specified head.

2.1.2 Pump and motor shall be mounted on a common M.S. structural or C.I. base plate or as required as per site conditions.

2.1.3 Each pump shall be provided with a totally enclosed fan cooled induction motor of required H.P. and RPM specified in the bill of quantities and as per requirement.

2.1.4 Each pumping set shall be provided with a 150mm dia or of suitable size gunmetal "Bourden" type pressure gauge with gunmetal isolation cock and connecting piping.

2.1.5 Provide vibration-eliminating pads appropriate for each pump.

2.1.6 Provide rate of flow measuring meter with bypass arrangement with every set of pumps as shown on the drawings and given in the bill of quantities (to be paid separately).

2.1.7 All water supply pumps shall be provided with mechanical seals, of required specifications.

3.0 SUMP PUMP

3.1 Sump pumps shall be submersible type for lifting domestic sewage or muddy water/drainage as specified in Bill of Quantities. Pump with impeller of approved material shall be mounted on waterproof motor. The impeller shall be suitable for handling solids upto 28-100mm dia. or as specified in Bill of Quantities.

3.2 The pump shall automatically operate with high water level and stop at low water level in the sump by means of "Electronic Level Controller", of the approved make.

3.3 The sump pumps shall be complete in all respect and shall be installed as per manufacturer's requirement as shown in the drawing. All accessories shall be In-Built as per manufacturer's specification.

4.0 WATER FILTER

4.1 Water filter shall be of dual filter media pressure filter downward or upward flow type suitable for a rate of filtration given in bill of quantities.

4.2 Filter shall be vertical type of required diameter. The shell shall be fabricated from M.S. plate suitable to withstand a working pressure given in bill of quantities. The minimum thickness of shell will be 8mm and dished ends shall be 10mm. The filter shall have at least one pressure tight manhole cover or as specified in Bill of Quantities.

Filter shall be provided with screwed or flanged connections for inlet, outlet, individual drain connections and all other connections necessary and required. Filter shall be painted inside with two or more coats of non-toxic corrosion resistant paint, one coat of red oxide primer outside with two or more coats of synthetic enamel paint of approved shade.

4.3 Under Drain System

Filter shall be provided with an efficient under drain system comprising of collecting pipes, gunmetal/polypropylene nozzles of manufacturer's design. The entire under drain system be provided on M.S. plate or cement concrete supports.

4.4 Face Piping

Filter shall be provided with interconnecting face piping comprising of inlet, outlet, and backwash pipe complete with pipes, valves and accessories, as per requirement. Piping shall be G.I/M.S. piping, medium duty and valves shall be cast iron double flanged sluice valves on SOUNDERS pattern with C.I. body and Neoprene rubber diaphragm (Suggested make LABLINE, AIP or equivalent).

4.5 Accessories

Each filter shall be provided with following accessories:-

a) Air release valve with connecting piping.
b) 150mm dia dial bourden type gunmetal pressure gauges with gunmetal isolation cock and connecting piping on inlet and outlet.
c) Sampling cocks on raw water inlet and filtered water outlet.
d) Individual drain connection with gunmetal full way valve.
e) Connection with valve for air scouring.

5.0 WATER SOFTENER

5.1 Softener shall be designed to give zero commercial hardness. Softener shall be with cation exchange resins.

5.2 Softener vessel shall be of mild steel plate with dished ends and self-supporting arrangement. Vessel shall be suitable for a working pressure given in bill of quantities. The shell shall have a minimum thickness of 8mm and dished ends 10mm. The vessel shall be painted internally with non-toxic bitumen paint and externally with one cost of red oxide and two or more coats of synthetic paint to give an even shade and as specified in bill of quantities.

5.3 The vessel shall have an internal collecting and distribution system of manufacturer's design.

5.4 The softener shall have a set of interconnecting face piping consisting of inlet, outlet and brine injection system with valves and accessories complete as per requirement. Piping shall be G.I/M.S. medium duty, and valves shall be cast iron double flanged sluice valves on SOUNDERS pattern, with C.I. body and Neoprene rubber diaphragm (suggested make LABLINE, AIP or equivalent).

5.5 One set of hydraulic injector with control valve, brine delivery pipes with adjustable indicator.

5.6 One cylindrical salt saturator and measuring tank of M.S. rubber lined having a capacity of a minimum of two regenerations for one softener or as specified in bill of quantities.

5.7 One orifice board for indicating wash and rinse rate to be fitted in drain sump.

5.8 One charge of supporting gravel, sand and "cation" resin in requisite quantity. Resin shall be approved make.

5.9 One water testing kit with instructions for testing water samples.

6.0 PIPING

6.1 Pipes for suction and delivery shall be galvanized/M.S tube (heavy duty) upto 150mm dia and for dia 200mm and above or as specified in bill of quantities.

6.2 Gate valve and check valve above 65mm dia shall be C.I. double flanged manufactured by the reputed manufacturers or C.I. double flanged butterfly valves as specified in bill of quantities or elsewhere or as per approval of Engineer-in-charge.

6.3 Full way and check valves 65mm dia and below shall be gunmetal tested to 20Kg/cm^2 pressure certified.

6.4 Suction strainer or foot valves shall be C.I., as specified in bill of quantities.

6.5 Joints

All pipes and fittings shall be provided with flanged joints, with flanges either screwed or welded complete and jointed with 1.5mm thick gasket complete with nuts, bolts and washers etc.

6.6 Testing

All G.I/M.S pipes (except fire pipe) shall be tested hydrostically for a period of 30 minutes to a pressure of 7 Kg/cm^2 without drop in pressure and all G.I/M.S pipes for fire shall be tested hydrostically for a period of 6 hours to a pressure of 10 Kg/cm^2 without drop in pressure.

7.0 VIBRATION ELIMINATORS

Provide on all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump. Length of the connector shall be as per manufacturers details.

8.0 MEASUREMENTS

8.1 Raw water, garden pump and fire pumps shall be measured by numbers and hydro pumps and sump pumps shall be measured by sets and shall include all items as given in the bill of quantities.

8.2 Motor control panel and level controllers shall be measured by numbers.

8.3 Pipes for suction and delivery header and mains shall be measured per linear metre along the centre line of the pipe and shall be inclusive of all fittings.

8.4 Cable trays and cables shall be measured per linear meter.

8.5 Structural clamps including hangers shall be measured by weight calculated from sections used. No separate payment shall be admissible for bolts, anchor bolts, rawl plugs etc.

8.6 No separate payment shall be made for making connections of the existing service lines to the pumps. Vibration eliminator pads are included in the scope of this work.

9.0 **GUARANTEE**

9.1 The contractor shall submit a warranty for all equipment, materials and accessories supplied by him against manufacturing defects, malfunctioning or under capacity functioning.

9.2 The form of warranty shall be as approved by the Engineer-in-charge.

9.3 The warranty shall be valid for a period of one year from the date of commissioning and handing over.

9.4 The warranty shall expressly include replacement of all defective or under capacity equipment, Engineer-in-charge may allow repair of certain equipment if the same is found to meet the requirement for efficient functioning of the system.

9.5 The warranty shall include replacement of any equipment found to have capacity lesser than the rated capacity as accepted in the contract. The replacement equipment shall be approved by the Engineer-in-charge.

END OF SECTION - I

ELECTRICAL OPRATED HOT WATER GENERATION ALLIED EQUIPMENT

1.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of Electrical Hot water & allied equipment's complete in all respect conforming to these specifications and in accordance with requirement of schedule of quantities, and as per following indicative list.

1.2 HOT WATER GENERATION BOILER

The hot water generation boiler shall have capacity as specified in the Bill of Quantities.

Hot water generation boiler shall be vertical/horizontal water tube reverse flow unit robustly constructed with shell plate as approved BOQ .

1.6 PERFORMANCE TEST

Following listed tests shall be conducted after installation of the boiler:

a. Capacity test

b. All controls and safety test.

c. Efficiency test to confirm 88% on NCV (at specified fuel consumption)

d. Safety valve blow test

e. Hydraulic test.

All necessary equipments or instruments required for conducting above tests shall be arranged by the contractor. Hot water generation boiler will be approved subject to clearance of above tests.

1.7 HOT WATER GENERATION BOILER INSPECTION

Contractor shall arrange the inspection at works by the consultant and client, of the hot water generation boiler prior to dispatch.

1.8 DRAWINGS

Contractor shall furnish following drawings in triplicate within one month form the date of order to the consultants.

a) Foundation details of each hot water generation boiler

b) Hot water generation boiler electrical wiring diagram

c) Hot water generation boiler operation manual

d) P & I diagram

e) General arrangement & Terminal point details

f) Proposed layout of hot water generation boiler house.

SOLAR HOT WATER BACKUP GENERATION SYSTEM

The Solar Hot Water generation system shall be consisting of the specifications as per the guidelines given below and as mentioned in the BOQ

1. **PIPING**

1.1 Pipes for suction and delivery shall be galvanized as specified in Bill of Quantities.

1.2 Gate valve and check valve above 65mm dia shall be C.I. double flanged manufactured by KIRLOSKAR, BURN, KILBURN, LEADER or C.I. double flanged Butterfly Valves as specified in Bill of Quantities or elsewhere.

1.3 Ball Valve and Check valves 65mm dia and below shall be gunmetal tested to 20Kg/Sq.cm pressure certified.

1.4 Suction Strainer or Foot Valves shall be C.I., as specified in Bill of Quantities.

1.5 **Joints**

All pipes and fittings shall be provided with screwed joints upto 65mm dia and flanged joint above 65mm dia, with flanges screwed complete and jointed with 3.0mm thick gasket complete with nuts, bolts and washers etc.

1.6 **Testing**

All G.I. pipes of Primary Circuit (Collector Circuits) shall be tested to hydrostically for a period of 30 minutes to a pressure of 2 Kg/Sq.cm without drop in pressure and all other G.I pipes for a pressure of 6 Kg/Sq.cm.

1.7 **MEASUREMENTS**

1.7.1 Pipes for suction and delivery header and mains shall be measured per linear metre along the centre line of the pipe and shall be inclusive of all fittings.

1.7.2 Solar flat plate collector consists of the following components shall be measured as detailed below:-

(a) Toughened /Tempered Glass cover plate/Glazing material
(b) Collector box
(c) Absorber
(d) Stand

1.8. **COVER PLATE**

1.9 The cover plate shall be tempered/toughened glass in single piece of 4.0mm thick with solar transmittance of 85% (minimum) at near normal incidence. The glass shall be free from bubbles and rough surface and shall satisfy “Thermal Shock Test”, “Impact test” and “Transmittance Test”.

2. **COLLECTOR BOX**

2.1 The collector box shall be made of aluminum as per BSI/NBS. The thickness should not be less than as specified herein after.

(a)	For Sides	--	Channel section of 100mmx25mmx1.6mm
(b)	For bottom	--	Sheet of thickness 0.71mm
(c)	For cover plate sheet	--	Angle section 25mmx25mmx1.2mm
(d)	For Body	--	Sheet thickness 1.0mm
(e)	Collector Size	--	1860mm x 1240mm x 100mm
(f)	Absorber Area of One Collector	--	2.1 Sq.m

2.2 All surfaces shall be smooth & free from roughness, raised sports, scale or any other surface defects. Sharp edges and corners shall be rounded off.

2.3 The collector box, the side channels are welded at the corner by inert arc welding or gas brazing. Bottom sheet shall be joined spot welding and any suitable method to give proper joint. The joints shall be made leak proof by suitable sealing compound.

2.4 Collector box shall be insulated with material to achieve heat resistance of 0.8m2 ^{o}C/W. The minimum thickness should not be less than 50mm.

2.5 Aluminum foil of thickness 0.012mm (min.) shall be used for covering the back as well as side insulation.

2.6 Back and side insulation shall withstand at 175 ^{o}C.

2.7 Gaskets & Grommets to be used for sealing the glass with collector box and header joints with collection box should be of such material, so that no dust can pass through the joint and shall be capable of withstanding up to 125 ^{o}C and shall conform to the standard Thermal Shock Test.

20.8 The heat resistance shall be determined as per latest edition of BSI/NBS.

2.9 **ABSORBER**

2.9.1 The absorber shall be of copper sheet Min. 0.15mm minimum thickness. The risers and header pipes shall be of Copper. The welding between Copper tube riser and Copper Sheet should be Laser -Welding.

2.9.2 The sheet shall be coated with selective coating to satisfy solar absorbility of more than 0.96 & emissivity < 0.12.

2.9.3 The selective coating shall not damage when the sample is raised to 200 ^{0}C temperature.

2.9.4 All tests such as solar absorbility test, emissivity test and temperature tests are to be carried out as per standard tests.

2.10 **STAND**

2.10.1 The stand for the collector and hot water storage tank are to be designed taking into consideration the load to be carried by the stand. The collector becomes vulnerable to wind dust. The collector may be up-listed by wind striking the underside. This wind load

should be determined according to accepted engineering practices and procedures and the stands is to be designed taking into consideration the worst condition of loading.

2.11 **HEAT EXCHANGER**

2.11.1 Stainless Steel:316 Plate type Heat Exchanger of suitable area shall be provided between Primary and Secondary circuits to prevent scale formation inside the tubes of Absorber of Collector and to transfer required heat energy from Primary to Secondary circuit.

SHOP DRAWINGS & SPECIFICATIONS

3.1 The Contractor shall submit to the Consultant two copies of Shop Drawings for all related works as an Advance Copy to the Engineer-in-Charge for approval before start of work. Subsequent to the approval of the shop drawings, the Contractor shall submit six copies of Shop Drawings for execution to the Engineer-in-Charge. Also the Contractor shall submit four copies of the Technical Specifications and Catalogues.

3.2 Shop drawings shall be submitted for the following conditions:

(a) Foundation Details of all relevant Equipment

(b) Detailed Layout plans as required and for coordination with other services, and for any changes in the layout drawings.

(c) All necessary schematics, sketches, individual component diagram, as per Instructions of the Engineer-in-Charge

3.3 The Contractor can only commence the work after the approval of above documents by Consultant.

END OF SECTION – III

SECTION – IV TECHNICAL DATA SHEETS

TECHNICAL INFORMATION FOR BOILERS/ACCESSORIES (TO BE FILLED BY THE TENDERER)

(The Tenderer should try to fill up the following informations as maximum as possible and they may submit additional informations which may be useful to support their technical specifications).

Sr.No.	Description	Hot Water Recirculation Pump	Hot water Pump (Secondary Circuit)	Condensate Return Pump
4.7	**PUMPS**			
4.7.1	Make & model No.	:		
4.7.2	Type	:		
4.7.3	Capacity	:		
4.7.4	Pumping Head	:		
4.7.5	Motor H.P/RPM	:		

END OF SECTION – IV

SCHEDULE OF TECHNICAL DATA

1. **BOOSTER PUMPS** **(VFD)**

Pump	:
Make	:
Type & Model	:
Discharge in LPS / GPM	:
Head (Meters of WC)	:
Shut off Head (Meters of WC)	:
Efficiency (%)	:
No. of Stages	
Suction End I.D.	:
Delivery End I.D.	:
Details of N.P.S.H.	:
Vibration Isolation Detail	:
Skid Details	:
Operating Weight	:
Overall Dimension (MM)	:
Mechanical Seal Detail	:
Material	
Body	:
Impeller	:
Type of Impeller	
Shaft	:
Is it suitable for direct coupling	:

Motor	:
Make	:
Model	:
Power Requirement (HP / KW)	:
R.P.M.	:
Rating	:
Over Load Capacity	:
Class of Insulation	:
Details of Additional protection in winding	:
Motor Efficiency	:
It it suitable for direct coupling to pump?	:
Type of rotary movement	:
Method of Starting	:
Size and type of cable for connections.	:
Number of variable frequency drive	:
Detail of VFD	:

Pressure Vessel

Make

Model Number

Material of construction (Vessel/Bladder)

Dimension

Overall capacity

Cut-in/Cut-out setting

Capacity at specified cut-in/cut-out
Overall dimension of skid mounted system
Weight (Static/Dynamic)

TECHNICAL SPECIFICATIONS FOR FIRE FIGHTING WORKS

I) FIRE PUMPS:

1.0 SCOPE:

Contractor shall furnish all labor, materials, equipment for supply, installation testing and commissioning of complete fire pumping system. In general, the item of works shall include but not limited to the following:

a) Electrically operated hydrant and sprinkler pumps, diesel engine driven pump, and jockey pump.
b) Complete electrical system for pumps.

2.0 FIRE AND JOCKEY PUMPS (ELECTRIC DRIVEN):

2.1 Contractor shall provide and install electrically operated fire pumps of capacity and head indicated in the Drawings/Bill of Quantities.

2.2 Pumping sets shall be single/horizontal and section. The delivery pressure at pump outlet shall be not less than 7.5 Kg./cm^2 in any case.

2.3 Pumps shall be capable of giving a discharge of not less than 150 % of the rated discharge at a head of not less than 65% of the rated head. The shut off head shall be within 120% of rated head.

2.4 The pump casing shall be of cast iron of grade FG 200 and parts like impeller, shaft sleeve, wearing ring etc. shall be of non-corrosive metal like bronze/brass/Stainless Steel. The shaft shall be of stainless steel.

2.5 Bearing of the pump shall be effectively sealed to prevent loss of lubricant or entry of dust or water.

2.6 The pump shall be provided with a plate indicating the suction lift, delivery head, discharge, speed and number of stages.

2.7 The pump casing shall be designed to withstand 1.5 times the working pressure.

3.0 MOTORS FOR ELECTRIC DRIVEN PUMPS:

3.1 Motor:

The motor shall be squirrel cage A.C. induction type suitable for operation on 415 volts 3 phase 50 Hz. System. The motor shall be totally enclosed fan cooled type conforming to protection clause IP 55. The class of insulation shall be F. The synchronous speed shall be 1500/3000 RPM as specified. The motor shall be rated for continuous duty and shall have a horse power rating necessary to drive the pump at 150% of its rated discharge with at least 65% rated head.

3.2 Motor Starter:

The motor starter shall be direct on-line type. The unit shall include suitable current transformer and ammeter of suitable range on one line to indicate the current. The starter shall not incorporate under voltage no voltage trip overload or SPP.

The starter assembly shall be suitably integrated in the power and control panel for the wet riser system.

4.0 JOCKEY PUMP (ELECTRIC DRIVEN):

4.1 The discharge of the Jockey Pump shall be 10% of rated discharge of the main fire pump. The pump shall be horizontally mounted End Suction type single stage as specified. The pump casing shall be cast iron and parts like impeller, shaft sleeve, wearing ring etc. shall be non-corrosive metal like bronze, brass or Stainless Steel. The shaft shall be of stainless steel. Bearings of the pump shall be

effectively sealed to prevent loss of lubricant or entry of dust/ water.

4.2 The pump casing shall be designed to withstand 1.5 times the working pressure.

5.0 FIRE PUMP (DIESEL ENGINE DRIVEN):

5.1 Pumping sets shall be Horizontally mounted end suction type single/multi stage type. The delivery pressure at pump outlet shall be not less than 7.5 Kg./cm^2 in any case.

5.2 Pumps shall be capable of giving a discharge of not less than 150 % of the rated discharge at a head of not less than 65% of the rated head. The shut off head shall be within 120% of rated head.

5.3 The pump casing shall be of cast iron of grade FG 200 and parts lime impeller, shaft sleeve, wearing ring etc. shall be of non-corrosive metal like bronze/brass/Stainless Steel. The shaft shall be of stainless steel.

5.4 Bearing of the pump shall be effectively sealed to prevent loss of lubricant or entry of dust or water.

5.5 The pump shall be provided with a plate indicating the suction lift, delivery head, discharge, speed and number of stages.

5.6 The pump casing shall be designed to withstand 1.5 times the working pressure.

6.0 DIESEL ENGINE:

6.1 Environmental Conditions:
The engine shall be required to operate under the conditions of environment as specified the place of installation.

6.2 Engine Rating:
The engine shall be cold starting type without the necessity of preliminary heating of the engine cylinders or combustion chamber (for example, by wicks, cartridge, heater plugs etc.). The engine shall be multi cylinder / vertical 4 stroke cycle, Radiator cooled, diesel engine, developing suitable HP at the operating speed specified to drive the fire pump. Continuous capacity available for the load shall be exclusive of the power requirement of auxiliaries of the diesel engine, and after correction for altitude, ambient temperature and humidity for the specified environmental conditions. This shall be at least 20% greater than the maximum HP required to drive the pump at its duty point. It shall also be capable of driving the pump at 150% of the rated discharge at 65% of rated head. The engine shall be capable of continuous non-stop operation for 8 hours and at least 3000 hours of operation before major overhaul. The engine shall have 10% overload capacity for one hour in any period of 12 hours continuous run.

The engine shall accept full load within 15 seconds from the receipt of signal to start. The diesel engine shall conform to BS 649, all amended upto date.

6.3 Engine Accessories:

The engine shall be complete with the following accessories:-

a) Fly wheel dynamically balanced.

b) Direct coupling for pump and coupling guard.

c) Radiator with hoses, fan, water pump, drive arrangement and guard.

d) Corrosion Resister.
e) Air cleaner, oil bath type / dry type.

f) Fuel service tank support, semi-rotary pump and fuel oil filter with necessary pipe work.

g) Pump for lubricating oil and Lub. oil filter.

h) Elect. starting battery (2 x 12 V).

i) Exhaust silencer with necessary pipe work.

j) Governor.

k) Instrument panel housing all the gauges, including Tachometer, hour meter and starting switch with key (for manual starting).

l) Necessary safety controls.

m) Winterization arrangement, where specified.

6.4 Cooling System:

The engine cooling system shall be Radiator cooled system. The radiator assembly shall be mounted on the common bed plate. The radiator fan shall be driven off the engine as its auxiliary with a multiple fan belt. When half the belts are broken, the remaining belts shall be capable of driving the fan. Cooling water shall be circulated by means of an auxiliary pump of suitable capacity driven by the engine in a closed circuit.

6.5 Fuel System:

The fuel shall be gravity fed from the engine fuel tank to the engine driven fuel pump. The engine fuel tank shall be mounted either over or adjacent to the engine itself or suitably wall mounted on brackets at a height not less than 60 cm above the fuel injection pump. The fuel filter shall be suitably located to permit easy servicing.

All fuel tubing to the engine shall be with copper, with flexible hose connections where required. Plastic tubing shall not be permitted.

The fuel tank shall be of welded steel construction (3mm thick) and of capacity sufficient to allow the engine to run on full load for at least 8 hours. The tank shall be complete with necessary floor mounted supports, level indicator (protected against mechanical injury) inlet, outlet, overflow connections and drain plug and piping to the engine fuel tank. The outlet should be so located as to avoid entry of any sediments into the fuel line to the engine.

A semi rotary hand pump for filling the daily service tank together with hose pipe 5 mtr. long with a foot valve etc. shall also form part of the scope of work or as specified in Bill of Quantities.

6.6 Lubricating Oil System:

Forced feed Lub. oil system shall be employed for positive lubrication. Necessary Lub. oil filters shall be provided, located suitably for convenient servicing.

6.7 Starting System:

The starting system shall comprise necessary batteries (2 x 12 V), 24 volts starter motor of adequate capacity and axle type gear to match with the toothed ring on the fly wheel. By metallic relay protection to protect starting motor from excessively long cranking runs suitably integrated with engine protection system shall be included within the scope of the work.

The capacity of the battery shall be suitable for meeting the needs of the starting system.
The battery capacity shall be adequate for 10 consecutive starts without recharging with cold engine under full compression.

The scope shall cover all cabling, terminals, initial charging etc.

6.8 Exhaust System:

The exhaust system shall be complete with silencer suitable for outdoor installation, and silencer piping including bends and accessories shall be complete in all respect and in accordance with CPCB norms. The total back pressure shall not exceed the engine manufacturer's recommendation. The exhaust piping shall be suitably lagged.

6.9 Engine Shut Down Mechanism:

This shall be manually operated and shall return automatically to the starting position after use.

6.10 Governing System:

The engine shall be provided with an adjustable governor to control the engine speed within 5% of its rated speed under all conditions of load upto full load. The governor shall be set to maintain rated pump speed at maximum pump load.

6.11 Engine Instrumentation:

Engine instrumentation shall include the following:-
a) Lub. Oil pressure gauge.
b) Lub. Oil temperature gauge.
c) Water pressure gauge.
d) Water temperature gauge.
e) Tachometer.
f) Hour meter.

The instrumentation panel shall be suitably resident mounted on the engine.

6.12 Engine Protection Devices:

Following engine protection and automatic shut down facilities shall be provided:-
a) Low lub. oil pressure.
b) High cooling water temperature.
c) High lub. oil temperature.
d) Over speed shut down.

Operating Conditions for the Service Pumps

Fire Service Pump	Nos.	Cut in Pressure	Cut Out Pressure	Remarks
Jockey pump	One	6.5 Kg/cm^2	7.5 Kg/cm^2	To auto start and auto stop on pressure switch on air vessel to stop.
Main pump (Hydrant)	One	5.0 Kg/cm^2	Push button manual	To auto start on pressure switch on air vessel and manual off.
Diesel Fire Pump	One	3.0 Kg/Cm^2	Push button manual	To auto start on pressure switch on air vessel and manual off.
Sprinkler Pump	One	5.5 Kg/Cm^2	Push button manual	To auto start on pressure switch on air vessel and manual off.

(The above ratings will be adjusted finally at the time of commissioning as per site requirement and final setting shall be kept as per approval of Engineer-in-Charge/Project Consultant)

6.13 Pipe Work:

All pipe lines with fittings and accessories required shall be provided for fuel oil, lub. oil and exhaust system, copper piping of adequate sizes shall be used for lub. oil and fuel oil. M.S. piping will be permitted for exhaust.

6.14 Anti Vibration Mounting:

Suitable vibration mounting duly approved by engineer-in-charge shall be employed for mounting the unit so as to minimize transmission of vibration to the structure. The isolation efficiency achievable shall be clearly indicated.

6.15 Battery Charger:

Necessary float and boost charger shall be incorporated in the control section of the power and control panel, to keep the battery under trim condition. Voltmeter to indicate the state of charge of the batteries shall be provided.

7.0 AIR VESSEL FOR FIRE PUMPS:

Provided on air vessel fabricated from 8mm M.S. sheet with dished ends and suitable supporting legs, air vessel shall be provided with a 100mm dia flanged connection from pump, one 25mm dia drain with valve, one Stainless Steel water level gauge and 25mm sockets for pressure switches. The vessel shall be 450mm x 1500mm dia. high and tested to 10.0Kg/Sq.cm pressure.

The fire pumps shall operate on drop of 1 Kg/Sq.cm pressure in the mains. The pump operating sequence shall be arranged in a manner to start the pump automatically but should be stopped manually by starter push buttons only.

8.0 CONTROL PANEL:

8.1 Cubical Panel:

The main switch board cubicle panel shall be of floor mounted type, totally enclosed, dust and vermin proof made from 16 SWG M.S. sheet of suitable size duly painted with one coat of anti-corrosive paint and two coats of synthetic enamel paint of approved make and shade with stove enameled finish. The cubical shall comprise of the followings:

a) Incoming main M.C.C.B unit of required capacity.

b) Outgoing M.C.C.Bs one for each motor.

c) Aluminium busbar of suitable capacity.

d) Fully Automatic "DOL" starter suitable for the motor H.P. with Push Buttons and ON/OFF indicating light one for each motor for all pumps.

e) Single phasing preventors one for each motor.

f) 96 mm^2 panel type Ampere meters - one for each motor complete with CTs.

g) 150 mm^2 voltmeter on incoming main with rotary selector switch to read voltage between phase to neutral and phase to phase.

h) Three neon phase indicating lamps.

i) Rotary switch for manual/auto operation.

j) All Colour coded internal and inter-connecting wiring from incoming main to busbar, switch board panel and power/control cables from switch board cubicle to motors, engine and batteries etc. complete in all respect.

All switchgears and accessories shall be approved make to relevant codes and to the satisfaction of Client's Representative/Consultant and rating of all equipment must match the KW of motors included and as per TAC rules. All electrical work to be carried out as per TAC and CPWD rules/specifications.

8.2 Earthing:

8.2.1 There shall be two independent earthing stations at least 3 meters away from the pump room. Each earth electrode shall consist of GI earth plate 600mmx600mmx6mm thick including accessories and masonry enclosure with cover plate having locking arrangement. All electrical apparatus, cable boxes and sheath/armour clamps shall be connected to the main bar by means of branch earth connection of 25mm x 5mm copper strip. All joints in the main bar and between main bar and branch bars shall have the lapping surface properly tinned to prevent oxidation. The joints shall be rivetted and sheathed. The main earthing strip shall be 25 x 6mm copper in 40mm dia G.I. pipe from earth electrode as required.

8.2.2 Earth plates shall be buried in a pit 1.2 x 1.2m at minimum depth of 3 meters below ground. The connections between main bar shall be made by means of these 10 mm studs and fixed at 100mm centers. The pit shall be filled with coke breeze, rock salt and loose soil. A G. I pipe of 50mm dia with perforations on the periphery shall be placed vertically over the plates to reach ground level or watering.

8.2.3 A brick masonry man hole 30x30x30cms size shall be provided to surround the pipe for inspection. A bolted removable link connecting main bar outside the pit portion leading to the plates shall be accommodated in this manhole for testing.

8.2.4 Earthing shall be done complete as per IEC.

8.3 Cabling:

8.3.1 All cables from switch board panel to the motors shall be PVC insulated and PVC sheathed armoured aluminium conductor power cables of 650/1100 V grade. The cables of required size shall be suitable for laying on surface of wall or in flooring with suitable clamps. Necessary cable trays shall deemed to be included in this item as per site requirements.

8.3.2 The termination shall be with brass compression glands suitable for PVC sheathed armoured aluminium conductor cable of 1.1 KV `A' grade of the required size.

9. 0 INSTALLATION:

Pump shall be installed as per manufacturer's recommendations. Pump sets shall be mounted on machinery isolation cork or any other equivalent vibration isolation fitting. Concrete floating foundation shall be provided by the Owner as per approved shop drawings and specifications. The isolation pads, foundation bolts etc. shall be supplied by the Contractor. Contractor shall however ensure that the foundation bolts are correctly embedded.

Pump sets shall preferably be factory aligned, whenever necessary, site alignment shall be done by competent persons. Before the foundation bolts are grouted and the couplings are bolted, the bed plate levels and alignment results shall be submitted to the Client's Representative.

10.0 TESTING:

Tenderers shall submit the performance curves of the pumps supplied by them. They shall also check the capacity and total head requirements of each pump to match his own piping and equipment layout.

On completion of the entire installation, pumps shall be tested, wherever possible, for their discharge, head, flow rate, B.H.P.
Discharge, head and B.H.P. (as measured on the input side) shall be field tested. Test results shall correspond to the performance.

11.0 MEASUREMENT:

11.1 Pumping sets, and switch board cubicle shall be measured by number and shall include all item necessary and required and given in the specifications.

11.2 Earthing and power/control cabling shall not be measured separately but included in switchgear cubicle and shall include all items necessary and required to complete the work as per specification and relevant code to the satisfaction of Client's Representative.

11.3 Pressure switches and pressure gauges shall not be measured separately, but included in respective pumping sets and shall include all items necessary and required to complete the work to the satisfaction of Client's Representative.

II) FIRE HYDRANT SYSTEM

1.0 Scope of work

a) Wet riser fire hydrant system (internal and external)
b) Automatic sprinkler system
c) Valves, suction and delivery connections and headers.
d) Hand appliances.
e) Pipe protection, painting, sleeves & minor civil works other than specifically mentioned in the tender.
f) Electrical installations.
g) Specialized protection as specified.
i) Testing and commissioning.

2.0 General Requirements

2.1 All materials shall be new of the best quality conforming to the specifications and subject to the approval of the Project Managers.

2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

2.3 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

2.4 Pipes shall be securely fixed to walls, and ceilings by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceilings and walls.

2.5 Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.

3.0 Pipes

All pipes within and outside the building in exposed locations and shafts including connections buried under floor shall be M.S. Pipes as follows:

a. Pipes 150 mm dia and below Heavy Class
b. Pipe 200 mm dia and above of thickness specified.

4.0 Pipe Fittings.

4.1 Pipes and fittings means tees, elbows, couplings, flanges, reducers etc. And all such connecting devices that are need to complete the piping work in its totality.

4.2 Fabricated fittings shall be not be permitted for pipe diameters 50 mm and below.

4.3 When used, they shall be fabricated, welded and inspected in workshops under supervision of Project Managers whose welding procedures have been approved by the TAC (Texas Administrative Code) as per TAC rule 4102 for sprinkler system and applicable to hydrant and sprinkler system. For "T" connections, pipes shall be drilled and reamed. Cutting by gas or electrical welding will not be accepted.

5.0 Jointing

5.1 Screwed (50 mm dia pipes and below)

Joint for black steel pipes and fittings shall be metal-to-metal thread joints. A small amount of red lead may be used for lubrication and rust prevention. Joints shall not be welded or caulked. (With screwed M.S. forged fittings).(Excluding inside flats)

5.2 Welded (65 mm dia and above)

Joints between M.S. and pipes and fittings shall be made with the pipes and fittings having "V" groove and welded with electrical resistance welding in an approved manner. Butt-welded joints are not acceptable. Buried pipes will be subject to X Ray test from an approved agency as per the TAC norms at the cost of contractor. (with welded M.S. fittings heavy class with "V" groove) (Including inside flats)

5.3 Flanges.

Flanged joints shall be provided on:

a) Straight runs not exceeding 30 m on pipelines 80 mm dia and above.

b) Both ends of any fabricated fittings e.g. bend tees etc. of 65 mm dia or larger diameter.

b) For jointing all types of valves, appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and required as good for engineering practice.

d) Flanges shall be with appropriate number of half thread nuts, bolts and make GKW, 3 mm insertion neoprene gasket complete.

5.4 Unions

Provide approved type of dismountable unions on pipes lines 65 mm and below in similar places as specified for flanges.

6.0 Excavation

Excavation for pipe lines shall be in open trenches to levels and grades shown on the drawings or as required at site. Pipe lines shall be buried to a minimum depth of 1.2 meter or as shown on drawings.

Wherever required contractor shall support all trenches or adjoining structures with adequate timber supports.

On completion of testing and pipe protection, trenches shall be refilled with excavated earth in 15 cms layers and consolidated.

Contractor shall dispose off all surplus earth with in a lead of 200 m or as directed by Project Manager.

7.0 Anchor Thrust Blocks

a) Contractor shall provide suitably designed anchor blocks in cement concrete to encounter excess thrust due to water hammer & high pressure.

b) Thrust blocks shall be provided at all bends & tees & such other location as determined by the Project Manager.

c) Exact location, design, size and mix of the concrete block shall be approved by the Project Manager prior to execution of work.

8.0 Valves

8.1 Ball Valves

a) Valves 50 mm dia & below shall be heavy type nickel plated Brass body screwed type with chromium plated brass balls, PTFE Teflon seating and gland packing tested to a hydraulic pressure of 20 kg/sq cm including coupling and Stainless Steel handle conforming to B.S. 5351 with female screwed ends.

b) All valves shall be approved by the Project Manager before they are allowed to be used on work.

8.2 Butterfly Valves Slim seal

Butterfly Valves shall be cast iron body and shall be of class P.N. 1.6 tested to 16 kg/cm^2 with following details :-

a) Disc shall be CI heavy duty electrolyses nickel plated abrasion resistant.

b) The shaft is EN-8 Carbon Steel with low friction nylon bearings.

c) The seat shall be drop tight constructed by bonding resilient elastometer inside a rigid backing.

d) Built in flanged rubber seals.

e) Actuator to level operated for valves above ground and T Key operated for valves below ground.

f) Built in flanges for screwed on flanged connections.

Manufacturer's details on fixing and installation will be followed.

8.3 Non-Return Valves (NRV) slim seal wafer type non return valves PN 1.6

a) Non return valves will be used at location to allow flow only in one direction and prevent flow in the opposite direction.

b) Non-return valves shall be wafer type check valve with cast iron body and disk, S. Steel pin and hinges, nitrite/neoprene seal, suitable for horizontal/vertical line installation.

8.4 Air vessel / Air Cushion tank.

Air cushion tank shall be of size and capacity indicated in schedule of quantities. It shall be provided at the top most point/points and/or in pump house (as specified). The tank shall be complete 25 mm dia. Brass Air Valve (Ball type), Stop Valve (25mm dia), Drain valve (25mm dia) and pressure gauge including 25mm dia. Mild Steel M.S. pipes and fittings, unions, etc. as required to complete the work as per site conditions.

8.5 Air Cushion tank shall be measured by numbers and shall include Air Valve, Pressure Gauge, and Globe Valves for testing and draining, M.S. Clamps, Pipes, Fittings, Tees Elbows Union and all other items required completing the work.

8.6 Orifice Flanges

Provide orifice flanges fabricated from 6 mm thick stainless-steel plate to reduce pressure on individual hydrants to restrict the operating pressure to 3.5 kg/cm^2 and allow a discharge of 560 lpm.

8.7 Drain Valve

Provide 25 mm dia black steel pipe (heavy class) with 25 mm Ball valve for draining any water in the system in low pockets.

8.8 Inspection & testing assembly

Inspection and testing of the sprinkler system shall be done by providing an assembly consisting of Stainless-Steel valves, Stainless Steel sight glass, bye-pass valve. The drain pipe beyond the valve upto the drainage point shall be measured with the pipe.

8.9 Pump test assembly

Provide on the main fire sprinkler header a 150 mm dia bye pass valve located in an accessible manner along with a rate of flow rotometer calibrated in lpm and able to read 200 % of the rated pump capacity. The delivery shall be connected to the fire tank.

8.10 Pressure Gauge

Pressure gauge shall be provided near all connections to hydrant system and isolation valves of sprinkler system and where required. Pressure gauge shall be 100 mm dia Stainless Steel Bourden type with Stainless Steel isolation cock, tapping and connecting pipe and nipple. The gauge shall be installed at appropriate level and height for easy readability.

9.0 Hydrant/valve chambers

9.1 Contractor shall provide suitable brick masonry chambers in cement mortar 1:5 (1 cement: 5 coarse sand) on cement concrete foundations 150 mm thick 1:5:10 mix (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) 15 mm thick cement plaster inside and outside finished with a floating coat of neat cement inside with cast iron surface box approved by fire brigade including excavation, back filling complete.

9.2 Valve chambers shall be 120 x120 cms. For depths up to 100 cms.

10.0 Fire brigade connections

Provide as shown on drawings separate Stainless Steel 4 way collecting head with four 63 mm instantaneous type inlets with built in check valves and 150 mm dia outlet connected to the fire and sprinkler main. Collecting head shall be installed on a stand post and provided with horizontal C.I. reflux valve and location to be approved by Project Manager. Provide etched Stainless Steel label plates with 50mm height letter. The plates should be firmly fixed to the FB connection and any support system.

11.0 Fire hydrants

11.1 External hydrants

a) Contractor shall provide external hydrants. The hydrants shall be single headed Stainless Steel landing valve with instantaneous type 63 mm dia outlet, controlled by a cast iron butterfly valve installed in underground lockable chambers. The hydrants shall be with bend, M.S. flanged riser of required height to bring the hydrant to correct level above ground.

b) Contractor shall provide for each external fire hydrant two numbers of 63 mm dia. 15 m long controlled percolating (CP) hose pipe with Stainless Steel male and female instantaneous type couplings riveted and bound with G.I. wire to hose pipe, Stainless Steel branch pipe with nozzle.

11.2 Internal hydrants

a) Contractor shall provide on each landing and other locations as shown on the drawings one single headed Stainless Steel landing valve with 63 mm dia outlet mounted on a common 80 mm inlet. Landing valve shall have flanged inlet and instantaneous type outlets as shown on the drawings.

b) Instantaneous outlets for fire hydrants shall be of standard pattern approved and suitable for fire brigade hoses.

c) Contractor shall provide for each internal fire hydrant station four numbers of 63 mm dia. 15 m long non percolating rubberized fabric lined hose pipes Type A with Stainless Steel male and female instantaneous type coupling riveted and bound with 1.5 mm copper wire to hose pipe, fire hose reel, Stainless Steel branch pipe with nozzle and Fire man's axe.

d) Each hose box shall be conspicuously painted with the letters "FIRE HOSE".

11.3 Fire hose reels

Contractor shall provide standard fire hose reels with 20 mm dia high pressure Dunlop rubber hose 36.5 m long with Stainless Steel nozzle and control valve, shut off valve, all mounted on circular hose reel of heavy-duty mild steel construction and cast-iron brackets. Hose reel shall be connected directly to the wet riser.

11.4 Hose Cabinets

a) Provide hose cabinets for all internal fire hydrants. Hose cabinets shall be fabricated from 16-gauge M.S. sheet of fully welded construction with hinged double front door partially glazed with locking arrangement, stove enameled fire red paint with "FIRE HOSE" written on it prominently. (Size as given in the Bill of Quantities).

11.5 Pipe protection

a) All pipes above ground and in exposed locations shall be painted with one coat of zinc chromate primer and two or more coats of synthetic enamel paint of approved shade.

b) Pipes in chase or buried underground shall be painted with two coats of zinc chromate primer and wrapped with one layer of 4 mm thick PYPCOTE or equivalent multi layer sheet as per standard manufacturer's specifications.

11.6 Pipe Supports

a) All pipe clamps and supports shall be galvanized steel. When fabricated from M.S. steel sections, the supports shall be factory galvanized before use at site. Welding of galvanized clamps and supports will not be permitted.

b) Pipes shall be hung by means of expandable anchor fastener of approved make and design (Dash Fasteners or equivalent). The hangers and clamps shall be fastened by means of galvanized nuts and bolts. The size/diameter of the anchor fastener and the clamp shall be suitable to carry the weight of water filled pipe and dead load normally accounted.

Pipe Spacing Table

		<---------- Pipe commercial dia. -----					----------	----------	------→
Sr.No.	**Pipes & Position**	15/20	20/25	32/40	50	75/80	100/110	150/160	200
1	**Vertical**								
1.1	GI /MS	2.4	2.4	3	3.6	4.5	4.5	5.4	5.4
2	**Horizontal**								

2.1	GI /MS	2.0	2.0	2.4	3.0	3.6	4.0	4.5	4.5

11.7 Testing

a) All piping in the system shall be tested to a hydrostatic pressure of 1.5 times the working pressure or 14 kg/sq.cm(whichever is more) without drop in pressure for at-least 2 hours.

b) Rectify all leakages, make adjustments and retest as required and directed.

12.0 Cables

a) Contractor shall provide control cables from supervisory valves and switches to the annunciation panels.

b) All control cables shall be copper conductor PVC insulated armored and PVC sheathed 1100-volt grade.

c) All cables shall have stranded conductors. The cables shall be in drums as far as possible and bear manufacturer's name.

d) All cable joints shall be made in an approved manner as per standard practice.

Cable Trays

i. All cables shall be routed in approved locations in coordination with all other services in a proper manner.

ii. Cable trays shall be of galvanized steel and hung from the ceiling by galvanized rods supported by appropriate size and type of expandable expansion fasteners drilled into the slabs and walls by an electric drill.

13.0 Measurement

a) Mild steel pipes shall be measured per linear meter of the finished length and shall include all fittings, flanges, and welding, jointing, clamps for fixing to walls or hangers, anchor fasteners, painting and testing complete in all respects.

b) Sluice and full way valves, check valves, installation valves, air valves & flow switches shall be measured by numbers and shall include all items necessary and required for fixing and as given in the specifications and bill of quantities.

c) Fire hydrants, hose reels, fire brigade connections, orifice flanges shall be measured by number and include all items given in the specifications and bill of quantities.

d) Fire hose and boxes specified shall be measured by number and include all items given in specifications and Bill of Quantities.

e) Fire extinguishers shall be measured by number and shall include full charge.

f) Cables and cable trays shall be measured per linear meter shall include clamps, hangers, anchor fasteners complete in all respects.

III) FIRE SPRINKLER SYSTEM

1.0 Scope of work

1.1 Work under this section shall consist of furnishing all labour, materials, equipment and appliances including scaffolding, M.S. ladders etc. necessary and required to completely install wet riser fire hydrant and sprinkler system as required by the drawings and specified hereinafter or given in the Bill of Quantities.

1.2 Without restricting to the generality of the foregoing, the work shall include but not limited to the following:-

a) Piping for Sprinkler systems.
b) Sprinkler heads, spare sprinklers
c) Inspection & test assemblies and accessories

2.0 General

2.1 All materials shall be new of the best quality conforming to the specifications and subject to the approval of the Project Manager.

2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

2.3 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

2.4 Pipes shall be securely fixed to walls, and ceilings by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceilings and walls.

2.5 Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.

3.0 Pipes

a) All pipes within and outside the building in exposed locations and shafts including connections buried under floor shall be M.S. pipes as follows:
b) Pipes 150 mm dia and below Heavy Class

4.0 Pipe Fittings

a) Pipes and fittings mean tees, elbows, couplings, flanges, reducers etc. and all Such connecting devices that are need to complete the piping work in its totality.

b) Screwed fittings shall be approved type malleable or cast iron with reinforced ring on all edges of the fittings suitable for screwed joints.

c) Forged steel fittings of approved type with "V" groove for welded joints.

d) Fabricated fittings shall be not being permitted for pipe diameters 50 mm and Below.

e) When used, they shall be fabricated, welded and inspected in workshops under supervision of Project Manager whose welding procedures have been approved by the TAC as per TAC rule 4102 for sprinkler system and applicable to hydrant and sprinkler System. For "T" connections, pipes shall be drilled and reamed. Cutting by gas or electrical welding will not be accepted.

5.0 **Jointing**

5.1 **Screwed (50 mm dia pipes and below)**

Joint for black steel pipes and fittings shall be metal to metal thread joints. A small amount of red lead may be used for lubrication and rust prevention. Joints shall not be welded or caulked.

5.2 **Welded (65 mm dia and above)**

Joints between M.S. and pipes and fittings shall be made with the pipes and fittings having "V" groove and welded with electrical resistance welding in an approved manner. Butt welded joints are not acceptable.

5.3 **Flanged**

Flanged joints shall be provided on:

a) Straight runs not exceeding 30 m on pipe lines 80 mm dia and above.

b) Both ends of any fabricated fittings e.g. bends, tees etc. of 65 mm dia or larger Diameter.

c) For jointing all types of valves, appurtenances, pumps, connections with other Type of pipes, to water tanks and other places necessary and required as Good for engineering practice.

d) Flanges shall be as per I.S. with appropriate number of G.I. nuts and bolts, 3 mm Insertion neoprene gasket complete.

e) Mild steel flanges shall be i.e "Plate Flanges for Welding" and flange thickness shall be as under .Gasket thickness shall not be less than 3 mm.

Pipe dia	Flange Thickness
200mm.	24 mm.
150 mm and 125 mm.	22 mm.
100 mm and 80 mm.	20 mm.

All hardware items such as Nuts, Bolts, and Washers shall be of appropriate size. Washers shall be used on both sides of the bolt.

5.4 **Unions**

Provide approved type of dismountable unions on pipes lines 65 mm and below in similar places as specified for flanges.

6.0 **Excavation**

6.1 Excavation for pipe lines shall be in open trenches to levels and grades shown on the drawings or as required at site. Pipe lines shall be buried to a minimum depth of 1.2 meter or as shown on drawings.

6.2 Wherever required contractor shall support all trenches or adjoining structures with adequate timber supports.

6.3 On completion of testing and pipe protection, trenches shall be refilled with excavated earth in 15 cms layers and consolidated.

6.4 Contractor shall dispose off all surplus earth within a lead of 200 m or as directed by Project Manager.

7.0 **Anchor Thrust Blocks**

a) Contractor shall provide suitably designed anchor blocks in cement concrete to encounter excess thrust due to water hammer & high pressure.

b) Thrust blocks shall be provided at all bends & tees & such other location as determined by the Project Manager.

c) Exact location, design, size and mix of the concrete block shall be approved by the Project Manager prior to execution of work.

8.0 Valves

8.1 Stainless Steel Valves

8.1.1 Valves 65 mm dia & below shall be heavy Stainless Steel full way valves or globe valves class II with female screwed ends. Valves shall carry BSI certifications mark.

8.1.2 All valves shall be approved by the Project Manager before they are allowed to be used on work.

8.2 C.I. Iron Butterfly Valves

8.2.1 All valves 80 mm dia and above shall be C.I. double flanged butterfly valves with rising spindle. Each sluice valve shall be provided with wheel for valves in exposed positions and cap top for underground valves. Contractor shall provide suitable operating keys for Sluice Valves with tops.

8.2.2 Butterfly valves shall be of best quality of class specified.

8.3 Non-return valves (Check Valves)

Non-return valves shall be cast iron double flanged with cast iron body and Stainless-Steel internal parts.

8.4 Air valves

Provide 25 mm dia screwed inlet cast iron single acting air valve, on all high points in the system or as shown on drawings.

8.5 Orifice Flanges

Provide orifice flanges fabricated from 6 mm thick stainless-steel plate to reduce pressure on individual hydrants to restrict the operating pressure to 3.5 kg/cm^2 and allow a discharge of 560 lpm. The contractor shall submit design of the orifice flanges for approval before installation.

8.6 Drain Valve

Provide 50 mm dia black steel pipe (heavy class) with 50 mm Stainless Steel full way valve for draining any water in the system in low pockets.

8.7 Inspection & testing assembly

Inspection and testing of the sprinkler system shall be done by providing an assembly consisting of Stainless-Steel valves, Stainless Steel sight glass, and bye-pass valve. The drain pipe beyond the valve upto the drainage point shall be measured with the pipe.

9.0 Pipe protection

a) All pipes above ground and in exposed locations shall be painted with one coat of zinc chromate primer and two or more coats of synthetic enamel paint of approved shade.

b) Pipes in chase or buried underground shall be painted with two coats of zinc chromate primer and wrapped with one layer of 4mm thick PYPCOAT multilayer sheet as per standard manufacturer's specifications.

10.0 **Pipe Supports**

10.1 All pipe clamps and supports shall be galvanized steel. When fabricated from M.S. steel sections, the supports shall be factory galvanized before use at site. Welding of galvanized clamps and supports will not be permitted.

10.2 Pipes shall be hung by means of expandable anchor fastener of approved make and design (Dash Fasteners or equivalent). The hangers and clamps shall be fastened by means of galvanized nuts and bolts. The size/diameter of the anchor fastener and the clamp shall be suitable to carry the weight of water filled pipe and dead load normally encounter.

11.0 **Sprinkler Heads**

11.1 Sprinkler heads shall be quartzoid bulb type with Stainless Steel body fully approved and having current certification of the fire laboratory of the C.B.R.I. Roorkee, Underwriter's laboratory (UL) and under the approved certified list of the Fire Office Committee (FOC) of U.K. or NFPA of USA. Any one of the certifications as acceptable to the local fire authorities obtained prior to the procurement and approved and accepted by the Project Manager.

11.2 Sprinkler heads shall be installed in conformity with approved shop drawings and in co-ordination with electrical fixtures, ventilation ducts, cable galleries and other services along the ceiling.

11.3 Following type of sprinklers shall be used:

Sr.No.	Type of Sprinkler	Temp rating ^{0}C
1.	Pendant or upright	68
2.	Special application quick wall Type with throw suitable for Room size of 5 m length (Extended type)	68
3.	Pendent type (Recessed in rossette)	68

11.4 Spacing and coverage of sprinkler shall be in accordance with risk classification of area in which they are installed, design density and TAC regulation.

12.0 **Spare Sprinklers**

a) Provide lockable enamel painted steel cabinet including following type of spare sprinklers

i) Semi concealed type

b) The cabinet should also contain one pair of wrenches (of each size of the same are different) for the sprinklers.

c) Spare sprinklers shall be of the same specifications as that of the original sprinklers specified.

13.0 **Testing**

13.1 All piping in the system shall be tested to a hydrostatic pressure of 14 kg/cm^2 without drop in pressure for at least 8 hours.

13.2 Rectify all leakages, make adjustments and retest as required and directed.

14.0 **Measurement**

14.1 Mild steel pipes shall be measured per linear meter of the finished length and shall include all fittings, flanges, and welding, jointing, clamps for fixing to walls or hangers, anchor fasteners, painting and testing complete in all respects.

14.2 Sluice and full way valves, check valves, installation valves, air valves & flow switches shall be measured by numbers and shall include all items necessary and required for fixing and as given in the specifications and bill of quantities.

14.3 Fire extinguishers shall be measured by number and shall include full charge.

14.4 Spare sprinkler cabinets with spare sprinklers specified and spanners shall be measured as per actual item given in the specifications and Bill of Quantities.

14.5 Sprinkler heads shall be measured by numbers.

IV) HAND APPLIANCES:

1.0 SCOPE:

Work under this section shall consist of furnishing all labour, material, appliances and equipment necessary and required to install fire extinguishing hand appliances.

Without restricting to the generality of the foregoing the work shall consist of the following:

Installation of fully charged and tested Fire Extinguishing Hand Appliances CO_2, Foam, Dry chemical powder type as required by these specifications and drawings.

2.0 GENERAL REQUIREMENTS:

2.1 Fire extinguishers shall conform to the Standard specifications and shall be with BIS approved stamp as revised and Amended upto date.

a) CO_2 Type
b) Foam Type
c) Dry Powder Type

2.2 Fire extinguishers shall be installed as per British Standard Institution Code/ NFPA of practice for selection, installation and maintenance of portable first aid appliances.

2.3 Hand appliances shall be installed in readily accessible locations with the Appliance brackets fixed to wall by suitable anchor fasteners.

2.4 Each appliance shall be provided with an inspection, testing, change of charge and other relevant data.

2.5 All appliances shall be fixed in a true workman like manner truly vertical and at current locations.

3.0 MEASUREMENTS:

Fire extinguishers shall be measured by numbers and include installation and all items necessary and required and given in the Bill of Quantities.

V) COMMISSIONING AND GUARANTEES

1.0 Scope of work

Work under this section shall consist of pre-commissioning, commissioning, testing and providing guarantees for all equipment, appliances and accessories supplied and installed by the contractor under this contract.

2.0 General requirements:

2.1 The rates quoted in this tender shall be inclusive of the works given in this section.

2.2 Contractor shall provide al tools equipment, metering and testing devices required for the purpose.

2.3 On award of work, contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

3.0 Pre-commissioning

On completion of the installation of all pumps, piping, valves, pipe connections, and water level controlling devices, the contractor shall proceed as follows:-

A Fire protection system:

i) Check all hydrant valves and close if any valve is open. Also check all suction and delivery connections are properly made.

ii) Test run and check rotation of each motor and correct the same if required.

B Pipe work

i) Check all clamps, supports and hangers provided for the pipes.

ii) Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specifications. If any leakage is found, rectify the same and retest the pipes.

4.0 Commissioning & testing

A. Fire hydrant system

i) Pressurize the fire hydrant system by running the main Electric Driven fire pump and after attaining the required pressure shutoff the pump.

ii) Open hydrant valve and allow the water to flow into the fire water tank in order to avoid wastage of water. The main fire pump should cut-in at the pre-set pressure and should not cutout automatically on reaching the normal line pressure. The fire pump should stop only by manual push button.

iii) Switch off the main fire pump and test check the diesel engine driven pump in the same manner as the electrically driven pump.

v) When the fire pumps have been checked for satisfactory working on automatic controls, open five hydrant valves simultaneously and allow the hose pipes to discharge water into the fire tank to avoid wastage. The electrically driven pump should run continuously for eight hours so that its performance can be checked.

vi) Check each landing valve, male and female couplings and branch pipes for compatibility with each other. Any fitting which is found to be incompatible and does not fit into the other properly shall be replaced by the contractor. Landing valves shall also be checked

by opening and closing under pressure.

B. Handing over

i) All commissioning and testing shall be done by the contractor to the complete satisfaction of the Project Manager, and the job handed over to the Project Manager, or his authorized representative.

ii) Contractor shall also hand over, to the Project Manager, all maintenance & operation manuals and all other items as per the terms of the contract.

C. Guarantees

i) The contractor shall submit a warranty for all equipment, materials and accessories supplied by him against manufacturing defects, malfunctioning or under capacity functioning.

ii) The form of warranty shall be as approved by the Project Manager.

iii) The warranty shall be valid for a period of one year from the date of commissioning and handing over.

iv) The warranty shall expressly include replacement of all defective or under capacity equipment. Project Manager may allow repair of certain equipment if the same is found to meet the requirement for efficient functioning of the system.

v) The warranty shall include replacement of any equipment found to have capacity lesser that the rated capacity as accepted in the contract. The replacement equipment shall be approved by the Project Manager.

VI) TECHNICAL DATA:

Contractor should furnish technical data as mentioned below, of the equipment and accessories offered by him as per scheme given in schedule of equipment and Bill of Quantities.

S. No.	Description	Unit	Condition of Services
1.0	**Pump Sets:**		
	FIRE HYDRANT PUMP		
1.1	Manufacturer		
1.2	Type		
1.3	Model		
1.4	Capacity		
1.5	Head (Ft.)		
1.6	Efficiency (%)		
1.7	Pump R.P.M		
1.8	B.H.P.		
1.9	Motor H.P.		
1.10	Motor Make (Manufacturer)		
1.11	Insulation Class		
1.12	Full Load Current (Amps)		
1.13	Current Characteristics		
1.14	Starting Current (Amps)		
1.15	Type of Starter		
1.16	Starter Make (Manufacturer)		
1.17	Impeller Material		
1.18	Impeller Diameter (mm.)		
1.19	Suction/Discharge Dia (mm.)		
1.20	Type of Bearing/Mechanical Seals		
1.21	Vibration Isolation		
1.22	Operation Weight (Kg.) Approx.		
1.23	Size: I mm W mm H mm		

2.0 Pump Sets:

DIESEL ENGINE DRIVEN PUMP

2.1 Manufacturer

2.2 Type

2.3 Model

2.4 Capacity

2.5 Head (Ft.)

2.6 Efficiency (%)

2.7 Pump R.P.M

2.8 B.H.P.

2.9 Motor H.P.

2.10 Motor Make (Manufacturer)

2.11 Insulation Class

2.12 Full Load Current (Amps)

2.13 Current Characteristics

2.14 Starting Current (Amps)

2.15 Type of Starter

2.16 Starter Make (Manufacturer)

2.17 Impeller Material

2.18 Impeller Diameter (mm.)

2.19 Suction/Discharge Dia (mm.)

2.20 Type of Bearing/Mechanical Seals

2.21 Vibration Isolation

1.22 Operation Weight (Kg.) Approx.

1.23 Size: I mm
W mm
H mm

3.0 Pump Sets:

SPRINKLER PUMP

3.1 Manufacturer

3.2 Type

3.3 Model

3.4 Capacity

3.5 Head (Ft.)

3.6 Efficiency (%)

3.7 Pump R.P.M

3.8 B.H.P.

3.9 Motor H.P.

3.10 Motor Make (Manufacturer)

3.11 Insulation Class

3.12 Full Load Current (Amps)

3.13 Current Characteristics

3.14 Starting Current (Amps)

3.15 Type of Starter

3.16 Starter Make (Manufacturer)

3.17 Impeller Material

3.18 Impeller Diameter (mm.)

3.19 Suction/Discharge Dia (mm.)

3.20 Type of Bearing/Mechanical Seals

3.21 Vibration Isolation

3.22 Operation Weight (Kg.) Approx.

3.23 Size: I mm
W mm
H mm

4.0 Pump Sets:

JOCKEY PUMP

4.1 Manufacturer

4.2 Type

4.3 Model

4.4 Capacity

4.5 Head (Ft.)

4.6 Efficiency (%)

4.7 Pump R.P.M

4.8 B.H.P.

4.9 Motor H.P.

4.10 Motor Make (Manufacturer)

4.11 Insulation Class

4.12 Full Load Current (Amps)

4.13 Current Characteristics

4.14 Starting Current (Amps)

4.15 Type of Starter

4.16 Starter Make (Manufacturer)

4.17 Impeller Material
4.18 Impeller Diameter (mm.)
4.19 Suction/Discharge Dia (mm.)

4.20 Type of Bearing/Mechanical Seals

4.21 Vibration Isolation

4.22 Operation Weight (Kg.) Approx.

4.23 Size: I mm
W mm
H mm