TENDER DOCUMENT

NIT No.: NRO/CON/773/681 dated 02.03.2019

FOR

Construction of Incubation Centre at Plot No. 4 & 5, Sector-7, GIDA, Gorakhpur for Software Technology Parks of India (STPI).

VOLUME – II

ADDITIONAL CONDITIONS OF CONTRACT
TECHNICAL SPECIFICATIONS & DRAWINGS

EXECUTING AGENCY

ENGINEERING PROJECTS (INDIA) LIMITED
(A GOVT. OF INDIA ENTERPRISE)
Core-3, Scope Complex,
7, Lodhi Road, New Delhi-110003
TEL NO: 011-24361666, FAX NO. 011-24363426
ADDITIONAL CONDITIONS OF CONTRACT (ACC)

1.0 The following Additional Conditions of Contract shall be read in conjunction with General Conditions of Contract. If there are any provisions in these Additional Conditions of Contract, which are at variance with the provisions of General Conditions of Contract, the provisions in these Additional Conditions of Contract shall take precedence.

2.0 INTRODUCTION

Software Technology Parks of India (STPI) at Gorakhpur has entrusted the Construction of Incubation Centre at Plot No. 4 & 5, Sector-7, GIDA, Gorakhpur to EPI as PMC (Deposit work). EPI on behalf of STPI has invited the NIT as open tender from the eligible bidders as per NIT.

3.0 Clause no. 8.0 of GCC regarding Mobilization advance is deleted and not applicable for this contract.

4.0 TAXES AND DUTIES

Clause no 13.0 of GCC is amended to the extent as stated as per Clause 13.0 of NIT.

5.0 FACILITIES TO BE PROVIDED BY PARTY TO EPI

GCC clause no. 28.3 stand deleted.

6.0 PAYMENT TERMS

In addition to Cl. No. 37 of General Conditions of Contract, the following shall also govern the terms of payment:

Payment will be made based on measurements entered in Measurement Book (MB) & certification of the same by Engineer – in-charge. The contractor shall remain bound to render all assistance to the Engineer – in-charge or his authorized representative during such checking of the measurements. The payment of running account bills / final bill shall be released on receipt of funds from STPI to EPI. The contractor does not have the right to claim delay in payments due to delay in receipt of funds from STPI

7.0 The Portland Pozzolona Cement (PPC) as per IS:1489-1991 or ordinary Portland Cement (OPC) as per IS:8112 shall be used in the works, however difference in price of PPC & OPC cement if is there shall be recovered from the contractor. The other provisions of clause 45.1 of GCC remain unchanged.

8.0 Thermo Mechanically Treated bars conforming to IS: 1786, Fe 500 grade as required, from approved manufacturers viz SAIL/RINL/TISCO or equivalent shall be used. The other provisions of clause 45.2 of G.C.C. remain unchanged.

9.0 Clause No.69.1 (IV) of GCC stands modified as under:

If the rates for the altered, additional or substituted work cannot be determined in the manner specified in sub-clauses (i) to (iii) of clause 69.1, then the Contractor shall, within 7 days of the date of receipt of order to carry out the work, inform the Engineer-in-Charge the rates which he intends to charge for such class of work, supported by analysis of the rate or rates
claimed, and the Engineer-in-Charge shall determine the rate or rates on the basis of prevailing market rates of the material, Labour, T&P etc. plus 15% (Fifteen percent) to cover the Contractors supervision, overheads and profit and pay the Contractor accordingly. The opinion of the Engineer-in-charge as to the current market rates of materials and quantum of labour involved per unit of measurements will be final and binding on the Contractor. However, the Engineer-in-Charge, by notice in writing, will be at liberty to cancel his order to carry out such class of work and arrange to carry it out in such manner, as he may consider advisable. But under no circumstances, the Contractor shall suspend the work on the plea of non-settlement of rates of items falling under the clause.

10.0 The clause No.72.1 of GCC shall be replaced as under:

The Contractor shall ensure adequate progress during the execution of work according to the detailed Bar Chart / PERT chart prepared by him and mutually agreed within 10 days from the date of LOI.

However, the Contractor shall also maintain monthly progress strictly in accordance with bar chart and / or detailed time schedule that will be worked out on the basis of completion schedule. If the Contractor fails to maintain the above progress or to complete the work and clear the site on or before the contract or extended date of completion, he shall without prejudice to any other right or remedy available under the law to EPI on account of such breach, pay as agreed compensation and not as penalty at the rate of half percent (1/2%) per week or part there or delay of the value of the work shown above if there is delay for a particular stage or the entire value of contract if the whole of the work is delayed.

The total amount of compensation payable by the Contractor for delay in stage-wise completion or completion of the whole work shall not exceed 10% of the total tendered value of work as awarded.

11.0 Clause No. 72.4.1 of GCC stands modified as under:

Within 10 (Ten) days of date of Letter of Intent, the contractor shall submit a Time and Progress Chart (CPM/PERT/Quantified Bar Chart) and get it approved by the Engineer-in-Charge. The Chart shall be prepared in direct relation to the time stated in the contract documents for completion of items / scope of the works. It shall indicate the forecast (milestones) of the dates of commencement and completion of various items trades, sections of the work and may be amended as necessary by agreement between the Engineer-in-Charge and the Contractor within the limitations of time imposed in the contract documents, to ensure good progress during the execution of the work. The physical report including photographs shall be submitted by the contractor on the prescribed format & the intervals (not later than a month) as decided by the Engineer-in-Charge. The compensation for delay as per clause 72.1 (revised as per ACC) shall be leviable at intermediate stages also, in case the required progress is not achieved to meet the time deadlines of the completion period and / or milestones of time and progress chart provided always that the total amount of compensation for delay to be paid under this condition shall not exceed 10% of the tendered value of work.

In case entire work is completed within the total time period of completion or extended period of completion allowed, the compensation for delay due to not achieving progress at intermediates stage, if any, shall be refunded without any interest charges.
12.0 ARBITRATION:

12.1 Clause no. 76.1 alongwith note

Deleted - There shall be no Arbitration Clause for this Contract except between Central Public Sector Undertakings inter se / Government of India Departments / Ministries as mentioned in the Clause No. 76.2 below:-

12.2 Clause No.76.3, stands modified as under:

JURISDICTION: The courts in Delhi/ New Delhi alone will have jurisdiction to deal with matters arising from the contract, to the exclusion of all other courts.

13.0 SPECIFICATIONS

13.1 The work in general shall be carried out as per latest CPWD specifications for Civil Works (updated with correction slips issued upto last date of submission of tender) and latest CPWD specification, unless otherwise specified in the nomenclature of the individual item or in the particular specifications of concerned items of works.

13.2 For items not covered under latest CPWD specification, for Civil Works specification and in particular specification or nomenclature of the individual item as above, the work shall be done as per latest relevant BIS codes of practice.

13.3 In case specification are not covered under para 13.1 & 13.2 above the work shall be carried out as per the provisions of technical specification.

13.4 In case of non availability of any specification in the above paras or any overlapping provisions, non-clarity on any issue, applicability of particular provision out of above, shall be decided by Engineer-in-Charge whose decision shall be final & binding on the contractor.

13.8 Specified material viz: cement, steel, structural steel etc shall be used. Material other than specified shall be used only with prior approval of EPI and recovery at prevailing market rate shall be done if material other than specified used.

14.0 PLANT & MACHINERY

All plant & machinery required for execution of work shall have to be arranged by the contractor at his own cost. However, the Contractor has to deploy following minimum plant & machinery at site immediately after award of work:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of Plant &amp; Machinery / Equipment</th>
<th>Min nos Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Excavator</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Dozer</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Truck</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Tractor with Trolley</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Water Tanker</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Batching Plant</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Transit Mixer</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Site mixture with weigh batcher</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>Skip hoist</td>
<td>As required</td>
</tr>
<tr>
<td>10</td>
<td>Dewatering / Water Pump</td>
<td>2 + 1</td>
</tr>
<tr>
<td>11</td>
<td>Survey Equipment</td>
<td></td>
</tr>
</tbody>
</table>

Signature of Contractor  Page 3  EPI
Additional Conditions of Contract
Engineering Projects (India) Limited

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Total Station</td>
<td>1</td>
</tr>
<tr>
<td>b</td>
<td>Theodolite</td>
<td>1</td>
</tr>
<tr>
<td>c</td>
<td>Level Instrument</td>
<td>2</td>
</tr>
<tr>
<td>12</td>
<td>Steel Shuttering</td>
<td>As required</td>
</tr>
</tbody>
</table>

Note:

a) Any other equipment for site test as outlined in CPWD specification and as directed by the Engineer-in-Charge.

b) The quantities of equipments indicated are tentative and can be increased as per the requirement of work programme OR as per the direction of Engineer-in-Charge. The above equipment list is indicative and not complete. The contractor has to deploy all the required equipment to complete all the works within stipulated specifications & time period as per contract documents.

c) The contractor will not be allowed to take out equipments from the site without the written permission of Engineer-in-Charge.

15.0 FINAL BILL

The final bill will be submitted by the contractor within 90 days from the date of acceptance of completion of work accompanied by the following documents:

a) Completion certificate issued by the Engineer-in-Charge specifying the handing over of the work including list of inventories (fittings & fixtures).

b) Computerized stage wise payment schedule.

c) No claim certificate by the contractor.

d) No claim certificate from the sub-agencies / vendors engaged by the contractor.

e) ‘As built’ drawings.

f) Periodical services and measurement books.

g) All statutory approvals from various state / central govt. local bodies, if required for completion & handing over of the work as included in scope of Contractor.

16.0 CONCRETING, SHUTTERING, STEEL WORK, ELECTRICAL, PV ENERGY SYSTEM, HVAC, ACCESS CONTROL & CCTV SYSTEM, STP, LIFTS WORKS ETC.

As per enclosed Technical Specification.

17.0 GENERAL

17.1 The contractor shall be responsible for all protection of electrical fittings & fixture against pilferage, breakage during period of installation until the completion of work and handed over to EPI.

17.2 The tenderers shall make necessary safety arrangements at site including as mentioned in GCC and indemnify EPI against any consequence of accident at site.

17.3 EPI is awarding this Contract on behalf of STPI. In case M/s. EPI cease to be an agency for the project, the right and responsibility etc. of EPI in the Contract shall get transferred to STPI or their nominated agency shall operate this Contract.
18.0 DEPLOYMENT OF TECHNICAL STAFF FOR THE WORK

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description of Staff</th>
<th>Min Qualification / Experience</th>
<th>Min Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Project Manager</td>
<td>B. E. (civil) with 10 year experience</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Site Engineer (Civil)</td>
<td>B. E. (civil) with 3 year experience Or Dip (civil) with 5 year of experience</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Site Engineer (Electrical)</td>
<td>B. E. (Elect) with 3 year experience Or Dip (Elect) with 5 year of experience</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Supervisor</td>
<td>Dip (civil) with 3 year of experience</td>
<td>3</td>
</tr>
</tbody>
</table>

19.0 ROAD PERMIT

Road permit for transportation of goods across state border shall not be issued by STPI / EPI and will have to be arranged by contractor on his own. Transit Insurance of the equipment shall be arranged by the contractor. Nothing extra shall be paid on this account.

20.0 Concrete mixed design by using approved admixture shall be carried out by the contractor at his own cost from approved laboratory before starting the work.

21.0 For items not covered under any of the specifications mentioned in Tender Documents, the works shall be carried out as per CPWD Specifications / manufacturer’s specifications/General Engineering Practice and/State Govt. or as per directions of Engineer-in-Charge. The rate for such extra work shall be derived as follows:

a) If the item is available in DSR 2016, contractor has to execute the item with the same rate.

b) If the item is not available in DSR 2016 and similar item is available, rate for such extra work shall be derived from the similar item by adding or deleting the differences below or at par tender percentage.

c) If the rate for any item is not possible to derive as mentioned above, the rate for which shall be derived by analyzing as per the prevailing market rates.

22.0 The Contractor shall procure Reinforcement steel and Structural steel required for the works directly from the Manufacturer/authorized dealer which mandatorily have to be primary procedure re-rolled reinforcement shall be used.

23.0 The contractor should invariably obtain necessary manufacturers test certificates from the suppliers of steel and cement for each and every consignment and furnish them to the Engineer-in-charge before use on works.

24.0 The original bills of procurement should be submitted to the Engineer-in-charge for making payment of the item. The contractor shall purchase the steel and cement on the name of work, the name of contractor and furnish the same to the Engineer-in-
charge. The steel and cement without the above two names will not be accepted on the works.

25.0 If any difference is observed on carriage inwards, carriage outwards and theoretical requirement of steel and cement for finished works, recovery at double the rate will be effected from the contractors bills for the quantity varied above the allowable limits.

26.0 For all Schedule BOQ items the nomenclature /rates/ unit of DSR items shall be followed. In case of any ambiguity is observed in Scheduled BOQ items relevant DSR item will hold good.

27.0 The Contractor shall be fully responsible to complete the “Works” in workmen like manner to the satisfaction of Client and EPI by maintaining high standard of quality and precision as per ‘Tender documents’, Agreements, Terms & Conditions, Specifications, Drawings etc., within the contractual completion period and within their quoted rates/amount. In case Client reduces or increases scope of work related to Contractor’s portion of work, the same shall be binding on Contractor and the Contractor has to execute the same at rates quoted by them.

28.0 In case Contractor is awarded the “Works” and fails to execute the same as per agreed schedule of progress of work and as per specified quality and/or lags behind in activities required for timely completion of “Works”, as determined by EPI/Client, then EPI shall give 15 days written notice to Contractor to achieve the specified quality and/or to deploy adequate resources to the satisfaction of EPI, for timely completion of “Works”. Upon expiry of the notice period, if Contractor fails to achieve specified quality and/or fails to take action for timely completion of “Works”, then EPI shall have option to withdraw the remaining work partly or in full from Contractor and get the same executed at the risk and cost of the Contractor from alternative agency/agencies.

29.0 The Contractor confirms that he holds EPF Code number, ESI registration number, PAN (Permanent Account Number of Income Tax), GST registration number etc. and shall be responsible for depositing EPF subscription and contribution for labour and staff employed by it on the “Works” and other taxes, duties and dues etc. as per statutory requirements and documentary evidence of same shall be provided to EPI. The Contractor shall also be responsible for labour welfare and for arranging labour and other licenses/ permits/ clearances etc. for the project at their own cost. The Contractor shall comply with all the requirements as per labour laws/acts. All the records in this regard shall be maintained by Contractor as per statutory requirements and rules and shall be produced by the Contractor on demand if required.

30.0 The Contractor shall be responsible for obtaining all approvals from EPI/Client with regard to quality of materials & workmanship and measurements etc. for their portion of work. The Contractor shall be responsible for reconciliation of issue material, if any. In case there is any shortfall of free issue items found during reconciliation,
recovery at double the cost of materials prevailing at that time of recovery shall be made from the Contractor’s due payment.

31.0 In case of non-approval of Contractor’s association for the Project by the Client and/or by the corporate office of EPI due to any reasons whatsoever at any stage of the “Works”, the Contractor shall have no claim on EPI.

32.0 The Contractor shall plan and execute the “Work” in his scope of work in such a manner that the other works, connected with the “Works” of the Contractor, but not included in Contractor’s scope of work do not get affected / delayed.

33.0 The quantities indicated in the BOQ are tentative. However contractor has to execute the works as per drawings and site conditions. Payment will be released for the work executed as per the rates quoted by contractor even if the quantities increases or decreases up to any extent.

34.0 The Contractor shall deploy sufficient plant & equipment of the required capacity and in good working condition for completion of the works in stipulated time with required quality. The equipment should either be owned by the Contractor or hired/leased. The deployment of equipment by Contractor shall be as decided by EPI and the same shall not be less than the minimum deployment stipulated, if any, for execution of “Works” and as per schedule agreed with EPI. The Contractor shall make arrangement for regular maintenance including preventive and breakdown maintenance and maintain stock of essential spares at site/near to site so as to ensure minimum breakdown time of equipment. The equipment once brought to site shall not be allowed to be removed without the consent of EPI. In case the Contractor fails to deploy sufficient equipment to the satisfaction of EPI or in case of prolonged breakdown of equipment, EPI at its sole discretion shall arrange the required equipment and debit all the related costs including ten percent overheads of EPI and shall recover the same from the due payments of Contractor, including from its bank guarantees available with EPI.

35.0 Contractor shall ensure compliance with all Central, State and Local Laws, Rules, Regulations etc. as applicable or may be applicable during the course of execution, maintenance etc. of the “Works” and shall indemnify EPI against any claim or damages whatsoever on such accounts. The Contractor shall keep EPI indemnified at all times against infringement of any Patent or Intellectual Property rights.

36.0 EPI is an IS0-9001 and ISO-14001 Company. The conditions of the ISO as applicable should be followed by the Contractor for implementation & maintaining the established procedures of EPI for this purpose. Following documents have been provided by EPI to Contractor & Contractor confirms receipt of the same:

a. Quality, Environmental, OH & safety policy
b. Environmental, Objectives & Targets
c. Operational control – Noise
d. Operational control – wastage
e. Operational control – energy
f. Operational control – Deforestation
g. Operational control – Plantation of trees
h. OH & S. management objects & targets
37.0 Project sign board to be supplied and erected at the site office as per the drawing enclosed.

38.0 The work executed by Contractor shall be subject to audit and quality control checks from Quality Control Division & Technical Audit of EPI, Client, Inspecting Agency of the Client and Chief Technical Examiner of Central Vigilance Commission, Govt. of India. In the eventuality of any defect/ sub standard works as brought out in the report or noticed otherwise at any time during execution, maintenance period etc., the same shall be made good by the Contractor. In case Contractor fails to rectify the defect/sub-standard work within the time period stipulated by EPI, EPI shall get it rectified at the risk and cost of Contractor and shall recover the amount from the dues of the Contractor.

39.0 EPI has agreed to award the work to the Contractor on the basis of details regarding experience profile, financial standing, credentials, fulfillment of statutory obligations, etc. of Contractor submitted by Contractor to EPI. In case, at a later stage if it is found that the Contractor has submitted incorrect, false details and credentials resulting in apprehensions on the capabilities of Contractor with regard to quality & timely completion of works, financial capabilities etc, EPI can terminate this order solely at its option. In this eventuality the Contractor shall be liable for the losses suffered by EPI and further Contractor shall have no claim on EPI, whatsoever.

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CONSTRUCTION OF INCUBATION CENTRE FOR SOFTWARE TECHNOLOGY PARK OF INDIA (STPI)

AT

PLOT NO. 4 & 5, SECTOR-7, GIDA, GORAKHPUR

VOLUMN – 2, Part - I

(CIVIL & SANITARY WORKS)
1.0 Introduction, Background, and General Information

Software Technology Parks of India, is an Autonomous Society set up by the Ministry of Electronics and Information Technology (MeitY), Government of India in 1991, with the objective of encouraging, promoting and boosting the Software Exports from India.

Software Technology Parks of India maintains internal engineering resources to provide consulting, training and implementation services. Services cover Network Design, System Integration, Installation, Operations and maintenance of application networks and facilities in varied areas.

2.0 Project Brief:

Location of IT Park will be Plot No.-GH-1, BL-5 in sector-7, GIDA, Gorakhpur.

For the purpose Gorakhpur Industrial Development Authority (GIDA) has provided a land measuring 3.604 Acres of land.

3.0 Scope of Work:

The scope of work for building under this contract includes for full & final and entire completion of all works including all internal and external services in all respects described in particular specification Part-I and as shown on drawings forming part of the contract.

The list of activities under mentioned are exhaustive but not limited to, any missing activity required for successful completion of work, should be considered part of scope of work.

Construction Stage
- Site Layout & Mobilisation
- Sanction of Electrical Connection & NOC's as applicable.
- Execution of the work as per approved design and details.
- Occupancy Certificate from Concern Authorities
- Handing over of site to the user after complete satisfaction.

Although all the details of construction have been by an large covered in these documents, any item or details of construction not specifically covered but obviously implied and essential to consider Civil works and all internal and external services complete and functional, shall be deemed to have been covered in the lumpsum quoted. The cost of external development works pertaining to a particular contract shall also be carried out on a final lump sum price based on the rates quoted for each item. The tenderer may however, consider a minimum level of specifications conforming to IS code or National Building Code to cover any missing details.
A: Special condition of Contract

1. The construction agency shall carry out the work as per the drawings & designs provided by the Architects M/s DESIGN HORIZONS for all the activities of work as per scope of work from time to time based on the construction schedule provided by the contractor.

2. The construction agency shall carry out the work in tandem with specialized agencies such as contractors for HVAC, Fire Fighting, External electrification, networking, Interior work, furniture suppliers etc in complete coordination.

3. The construction agency shall work under the supervision of Engineer in Charge of EPIL.

4. The construction agency shall deploy its well qualified & experienced technical staff as per tender terms of the contract to supervise & coordinate the work as per directions of EPIL.

5. The construction agency shall maintain higher standard of quality of construction & workmanship for all activities of work as per tender and BOQ including new items as per direction of EPIL.

6. Construction activities such as Internal electrical, data & voice wiring especially to work stations/ furniture, false ceiling, connection to main electrical panels, connection of Data wiring to Data switch, flooring and site development etc. shall be done in coordination in tandem with other contracting agencies and the contractor will be completely responsible for the same.

7. The finishing work such as stone cladding, tiling, flooring, paneling , railing fixing etc will be carried out as per drawings & details provided for the same from time to time to the construction agency by the architects.

B: Notes for Bill of Quantities

The broad items of work to be carried out by the construction agency are:

a) Demarcation of site boundaries, existing features, existing services etc
b) Construction of temporary site office and site godown.
c) Procurement of material at site.
d) Excavation of footing, trenches etc.
e) Column foundation work.
f) Casting of RCC column and beams
g) Laying of RCC slab at different floors
h) Brick work for different building.
i) Plastering and Finishing work (like stone cladding, Structural glazing, ACP cladding, and other finishing works)
j) Sunk area water Proofing and Terrace treatment
k) Painting and tile work.
l) Internal and external sanitary
m) Internal & External electrification work
n) False ceiling & paneling work
o) Flooring work
p) External roads, pathways, water supply, rain water harvesting, parking, boundary wall and development work
q) Inspection and handing over to RLDA.

C: Compliance for GRIHA Accreditation:

The Contractor will carry out construction work conforming to compliance for GRIHA accreditation for min 3 star rating. The sequence is segregated into specific sections. There are now only 31 criteria in the rating. For details refer GRIHA Version 2015.

Some of the points for compliance are elaborated as under:-

1. **Barricading**: The site boundary must be Barricaded up to height of 3m before excavation work started. This helps in preventing the eroded soil from the site going outside the site area.

2. **Excavation of Top Soil**: Top 200mm soil must be excavated & stored separately and stockpiled as a top soil. This top soil must be stored and used for a landscape in post occupancy stage.

3. **Top Soil Prevention**: The top soil must be covered with gravel, wood chips, temporary grass temporary plants etc to prevent it from erosion.

4. **Signage**: Display safety signage’s around the site.

5. **Water sprinkling**: Water sprinkling should be done on the ground on the regular basis to prevent erosion of soil due to vehicular movement. The undisturbed area at the project site must be barricaded for a safety concerns.

6. **FSC Certified wood shall be use**, which is 10%-15% costlier than normal wood.

7. **Low Flow Water fixtures must be used** with efficient flow rate.

8. **All Motors and pumps must be IE2 generation in terms of energy efficiency.**

9. **Tobacco smoke control**: Prohibiting smoking in the indoor areas / building or providing designated / isolated smoking zones within the building designed with separate ventilation.
10. **Sanitation /Safety facilities:** Safety of workers during construction with effective provisions for the basic facilities such as sanitation and drinking water, and safety of equipment or machinery.
PART – 1
CIVIL WORKS
1.0 Green Building Feature

1.1 Objective
A green building, which is also known as a sustainable building is designed to meet some objectives such as:
- Occupant health;
- Using energy, water, and other resources more efficiently; and
- Reducing the overall impact to the environment.

1.2 Green Building Features
- Eco-Friendly-by least disturbance to eco system.
- Energy efficient-through the natural lighting ventilation and solar passive designs
- Efficient use of water-through recycling and water harvesting
- Use of renewable energy-through photo voltaic systems and solar system etc.
- Non toxic material in door environment,
- Use of recycle/recyclable materials,
- Efficient waste utilization and disposal

1.3 Benefits of a Green Building Concepts
- Green buildings are designed to be healthier and having more enjoyable working environment. Work place qualities that improve the environment and which help in developing the knowledge of workers and may also reduce stress and lead to longer lives for multidisciplinary teams.
- Reduced energy and water consumption without sacrificing the comfort level.
- Significantly, better lighting quality including more day lighting, better daylight harvesting and use of shading, greater occupancy control over light levels and less glare.
- Improved thermal comfort and better ventilation.
- Limited waste generation due to recycling process and reuse.
- Increase productivity of workers and machines.

1.4 Benefits
1.4.1 Environmental Benefits
Protect bio diversity and eco systems, improve air and water quality, reduce waste streams, conserve natural resources.

1.4.2 Economic Benefits
Reduce operating cost, create, expand, and shape markets for green product and services, improve occupant productivity.

1.4.3 Natural Resources
According to surveys conducted in 2006, 107.3 million acres of total land area is developed, which represents an increase of 24 percent land covering green buildings over the past 3 years. In terms of energy, buildings accounted for 39.4 percent of total energy consumption and 67.9 percent of total electricity consumption.
1.5 Green Building Specifications

Green building specifications are part of Civil & MEP specifications.

2.0 Civil Works

1.0 Scope of Work

1.1 Detailed specifications of Civil Works

The Brief specifications of Civil Works of the building are given below.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Item</th>
<th>Sanctioned Provision/ Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Foundation</td>
<td>Isolated &amp; Combined footing as per structural design</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Burnt clay bricks in foundation and under plinth wherever required</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Depth of foundation as per geotech investigation recommendation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anti-termite treatment as per procedure mentioned in relevant IS codes</td>
</tr>
<tr>
<td>2.0</td>
<td>SUPER STRUCTURE</td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Structure</td>
<td>RCC framed construction with minimum 25% fly ash added to R.C.C. as per relevant IS code with intermediate columns where found necessary.</td>
</tr>
<tr>
<td>2.2</td>
<td>Filler Walls</td>
<td>Fly ash brick of 230 mm thick in cement mortar 1:6</td>
</tr>
<tr>
<td>2.3</td>
<td>Internal Partitions</td>
<td>Internal partition fly ash bricks for half brick wall masonry in cement mortar 1:4 including providing and placing 2 Nos. 6mm dia bars.</td>
</tr>
<tr>
<td>3.0</td>
<td>DOOR &amp; WINDOWS FRAME, SHUTTERS</td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Door</td>
<td>All Cabins - Door frames Pressed Metal Frame OR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Frameless toughened glass door with SS Handle and heavy duty floor spring.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Flush Door Shutters finished with laminate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WC Door - Flush Door Shutters finished with laminate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fire Door - MS Sheet Fire Door shutters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Main Entrance / Rear access Door - Toughened glass door with heavy duty floor spring.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Building Entry Door - Toughened glass door with heavy duty floor spring &amp; access controled</td>
</tr>
<tr>
<td>3.2</td>
<td>Windows</td>
<td>Internal courtyard - Windows / shutters in Aluminum frame/section with heat insulating single glazed reflective glass.</td>
</tr>
<tr>
<td>S.No.</td>
<td>Item</td>
<td>Sanctioned Provision/ Specification</td>
</tr>
<tr>
<td>-------</td>
<td>----------------------------</td>
<td>-----------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>4.0</td>
<td>FLOORING</td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>INTERNAL FLOORING</td>
<td></td>
</tr>
<tr>
<td></td>
<td>STPI’s Office area</td>
<td>- Double charged Superior grade vitrified tile flooring. (Glossy finish)</td>
</tr>
<tr>
<td></td>
<td>Plug &amp; Play</td>
<td>- Double charged Superior grade vitrified tile flooring. (Glossy finish)</td>
</tr>
<tr>
<td></td>
<td>Offices’ Toilets</td>
<td>- Matt finished vitrified tile flooring</td>
</tr>
<tr>
<td></td>
<td>Common Toilets</td>
<td>- Matt finished Ceramic tile flooring in WC area &amp; Marble flooring in common area</td>
</tr>
<tr>
<td></td>
<td>Entrance Lobby</td>
<td>- 18mm thk mirror polished Italian marble flooring</td>
</tr>
<tr>
<td></td>
<td>Meeting &amp; Conference Room</td>
<td>- Double charged Superior grade vitrified tile flooring. (Glossy finish)</td>
</tr>
<tr>
<td></td>
<td>Attium</td>
<td>- Matt finished vitrified tile flooring</td>
</tr>
<tr>
<td></td>
<td>Jamb &amp; Soffit</td>
<td>- Granite Jamb &amp; soffit as per design</td>
</tr>
<tr>
<td>4.2</td>
<td>EXTERNAL FLOORING</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Flamed Granite flooring</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Cement concrete flooring</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Green interlocking paver</td>
<td></td>
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<tr>
<td></td>
<td>- Exterior grade vitrified</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- For Roof Exposed to Sun</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(with 19mm thick closed cell elastomeric insulation material in the form of under deck)</td>
</tr>
<tr>
<td>5.0</td>
<td>RAILING</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stainless steel railings</td>
<td>(Grade 304).</td>
</tr>
<tr>
<td>6.0</td>
<td>ROOFING</td>
<td></td>
</tr>
<tr>
<td>6.1</td>
<td>Roof treatment</td>
<td>Coba treatment/ under deck insulation with extruded polystyrene finished with crazy ceramic flooring</td>
</tr>
<tr>
<td>6.2</td>
<td>False ceiling</td>
<td>Plaster of Paris Ceiling, Gyp. Board ceiling, Mineral fiber Grid Ceiling, Metal grid ceiling (In Wet</td>
</tr>
<tr>
<td>7.0</td>
<td>FINISHING</td>
<td></td>
</tr>
<tr>
<td>7.1</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Internal plaster shall</td>
<td>1. Internal plaster shall be in 12/15mm thickness in walls and 6mm on ceilings.</td>
</tr>
<tr>
<td></td>
<td>2. All internal walls and</td>
<td>2. All internal walls and ceilings to be treated with 1mm thick POP punning.</td>
</tr>
<tr>
<td></td>
<td>ceilings to be treated</td>
<td>3. Internal walls with Acrylic emulsion paint of interior grade, having VOC (Volatile Organic</td>
</tr>
<tr>
<td></td>
<td>with 1mm thick POP punning</td>
<td>Compound) content less than 50grams/liter.</td>
</tr>
<tr>
<td></td>
<td>4. Cement plaster in all</td>
<td></td>
</tr>
<tr>
<td></td>
<td>areas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Roller Blinds in rooms</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. Glazed ceramic tile dado</td>
<td>6. Glazed ceramic tile dado in toilets up to 2100 ht</td>
</tr>
<tr>
<td>7.2</td>
<td>External</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Combination of structural</td>
<td></td>
</tr>
<tr>
<td></td>
<td>glazing, Dry stone</td>
<td></td>
</tr>
<tr>
<td></td>
<td>cladding and cement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>plastered with exterior</td>
<td></td>
</tr>
<tr>
<td></td>
<td>paints.</td>
<td></td>
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<tr>
<td></td>
<td>2. Premium acrylic</td>
<td>2. Premium acrylic emulsion external grade, having VOC</td>
</tr>
<tr>
<td></td>
<td>emulsion external grade,</td>
<td>(Volatile Organic Compound) content less than 50 grams/liter.</td>
</tr>
<tr>
<td></td>
<td>having VOC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Volatile Organic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compound) content less</td>
<td></td>
</tr>
<tr>
<td></td>
<td>than 50 grams/liter.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>layered glass / High</td>
<td>frame &amp; Structural glazing.</td>
</tr>
<tr>
<td></td>
<td>performance single glass</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in windows with Aluminum</td>
<td></td>
</tr>
<tr>
<td></td>
<td>frame &amp; Structural</td>
<td></td>
</tr>
<tr>
<td></td>
<td>glazing.</td>
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</tr>
<tr>
<td>S.No.</td>
<td>Item</td>
<td>Sanctioned Provision/ Specification</td>
</tr>
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<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>4</td>
<td>Glass Fiber Reinforced Concrete (GRC) jali.</td>
<td></td>
</tr>
</tbody>
</table>
|       | False Ceiling                | - Plaster of Paris Ceiling, Gyp. Board ceiling, Armstrong Grid Ceiling, Metal grid ceiling (In Toilet & pantry).  
|       |                               | - Laminate finish over 9 mm thick commercial ply                                                |
|       |                               | - Superior Grade laminate finish over 9 mm thick commercial ply                                 |
|       | Wall Paneling                 | - 1.5 mm thick laminate over 4 mm ply/ MDF over 9 mm thick ply/ MDF over hard wood/ MS tubular frame (50x25x2 mm) with groove finished with polished veneer / back painted glass |

### 1.2 General Specification for CPWD DSR Items

Latest CPWD specification shall be adopted. Presently CPWD specifications 2009 volume I & II with latest correction slips to be followed. These specifications cover all type of Building Works. These specifications are available as printed documents of CPWD and also in soft copies on CPWD website.

- The intent of this technical specification covers all construction of all civil works as covered in the scope of contract.

- All civil works shall be carried out as per design/drawings standardized by the Consultant / Owner and the specification provided by the Consultant / Owner. Tender drawings are enclosed with the tender documents. Any item for which specification is not provided herein and is not covered under CPWD specification shall be executed as per as approved by the owner / consultant. The contractor shall intimate in writing and take prior approval of owner before execution. All materials shall be of best quality conforming to relevant Indian Standards and Codes. In case of any conflict between Standards/ Code and Technical Specification, the provisions of Technical Specification shall prevail, and the owner / consultant decision on interpretation shall be final.

- The Contractor shall furnish all labour, tools, equipment, materials, temporary works, constructional plant and machinery, fuel supply, transportation and all other incidental items not shown or specified but as may be required for complete performance of the Works in accordance with drawings, specifications and direction of Owner.

- Top soil need to be preserved as per the guideline of GRIHA. Excavated earth is to be disposed from site as instructed, only into approved landfill areas and dump yard, and the contractor will indemnify EPIL from any liability towards the same. The cost of excavation to include for necessary lead and lift as specified.

- All materials including cement, reinforcement steel and structural steel etc. shall be arranged by the Contractor. All testing required shall be arranged by the Contractor at his own cost. The contractor shall execute the work as per the standard Field Quality Plan (FQP) of EPIL.

- The bidder shall fully apprise himself of the prevailing conditions at the proposed site. Climatic conditions including monsoon patterns, local conditions and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications. All
considerations under the Government’s Green Rating of Integrated Habitat Assessment-
GRIHA - to be mandatorily followed by the contractor while executing all aspects of the
works.

- Level and date of concreting shall be marked on the building from outside at very floor
  level with proper paint, etc.

- All levels and survey work shall be measured by total station and electronic level machine
  at all floors and places.

1.3 TECHNICAL SPECIFICATION FOR NON SCHEDULE ITEMS

1.3.1 GRC Jali

Item Description
Supply & Fixing of Grc Jali As Per approved designs & sizes, with 50 mm thickness
border and 25-30 mm thickness from the Inner side. The Screens should be made
from ‘53 grade’ White Portland Cement manufactured by ‘Birla Cement’ or
equivalent, Quartz, Fine Silica Sand, Alkali Resistant Glass Fiber manufactured by or
equivalent, Super Plasticizers and polymers shall be manufactured by ‘BASF’ or
equivalent and U.V resistant Synthetic inorganic pigments should be used for
pigmentation manufactured by ‘BAYFERROX (Germany)’ or equivalent. The
material casting should take place in Synthetic Rubber / FRP Mould manufactured
by ‘Reckli’ or equivalent.

Fixing
The jali shall be set in position true to plumb and level before the joints sills and
soffits of the openings are plastered. It shall then be properly grouted with cement
mortar 1:3 (1 cement :3 coarse sand) and rechecked for levels. Finally the jambs,
sills and soffits shall be plastered embedding the jail uniformly on all sides.

Measurements
The jali shall be measured for its gross superficial area. The length and breadth shall
be measured correct to a cm. The thickness shall not be less than that specified.

1.3.2 Chicken Mesh under Plaster

Item Description
P/F hexagonal chicken mesh having opening 20mmx20mm of 26 gauge at juncitons of
cement & brick work or between different material etc. as directed.by Engineer-in-
charge.

Material and Workmanship: As per item description and general specifications.

Mode of measurement and Payment: The item shall be measured in Sqm of surface
area.

1.3.3 Filling of Sunken Areas

Item Description
Filling of sunk portion of roof with foam concete of required height including filling
complete levelling and dressing the surface by 50mm thick cement concrete 1:2:4 as per
specification.
Material and Workmanship: As per item description and manufacturer’s specifications.

Mode of measurement and Payment: The item shall be measured in Cum of filling area.

1.3.4 Vitrified / Ceramic Tile Flooring

Item Description
(i) Providing and laying Anti Skid Vitrified floor tile in different sizes (thickness to be specified by the manufacturer) with water absorption less than 0.08% matt and conforming to IS: 15622, of approved make, in all colours and shades, laid on 20mm thick cement mortar 1:4 (1 cement : 4 coarse sand), jointing with grey cement slurry @ 3.3 KG/ SQM including grouting the joints with white cement and matching pigments etc., complete (Kajaria Eternity 60x60cm, THE STAR shade Botticino Classico to Oslo Ocre or equivalent.)

(ii) Providing and laying superior grade glazed vitrified tiles in different sizes (thickness to be specified by the manufacturer) with water absorption less than 0.08% matt and conforming to IS: 15622, of approved make, in all colours and shades, laid on 20mm thick cement mortar 1:4 (1 cement : 4 coarse sand), jointing with grey cement slurry @ 3.3 KG/ SQM including grouting the joints with white cement and matching pigments etc., complete (Kajaria Eternity 80x80cm, THE SQUARE shade Perlato Royal to Shara Bronze or equivalent.)

(iii) Providing and laying Anti Skid Ceramic floor tile of size 300x300 mm (thickness to be specified by the manufacturer) of 1st quality conforming to IS: 15622 of approved make in colours such as White, Ivory, Grey, Fume Red Brown, laid on 20 mm thick cement mortar 1:4 (1 Cement : 4 Coarse sand), jointing with grey cement slurry @ 3.3 kg/sqm including pointing the joints with white cement and matching pigment etc., complete. (Kajaria Eternity 30x60cm, shade Beola Marfil to Oxford Gris or equivalent.)

(iv) Providing and laying matt finished Ceramic floor tile of size 300x300 mm (thickness to be specified by the manufacturer) of 1st quality conforming to IS: 15622 of approved make in colours such as White, Ivory, Grey, Fume Red Brown, laid on 20 mm thick cement mortar 1:4 (1 Cement : 4 Coarse sand), jointing with grey cement slurry @ 3.3 kg/sqm including pointing the joints with white cement and matching pigment etc., complete. (Kajaria Eternity 30x60cm, THE TREND shade marble decor to Coreno Beige or equivalent.)

Fixing
Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tile shall be with cement mortar 1:4 (1 cement : 4 coarse sand) or as specified. The average thickness of the bedding shall be 20 mm or as specified while the thickness under any portion of the tiles shall not be less than 10 mm.

Mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it.

Over this mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of cement per square metre over an area up to one square metre. Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is
properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long, so as to obtain a true surface with the required slope. In bath, toilet W.C. kitchen and balcony/verandah flooring, suitable tile drop or as shown in drawing will be given in addition to required slope to avoid spread of water. Further tile drop will also be provided near floor trap.

Where full size tiles cannot be fixed these shall be cut (sawn) to the required size, and their edge rubbed smooth to ensure straight and true joints. Tiles which are fixed in the floor adjoining the wall shall enter not less than 10 mm under the plaster, skirting or dado.

After tiles have been laid surplus cement slurry shall be cleaned off.

The joints shall be cleaned off the grey cement slurry with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigment if required to match the colour of tiles. Where spacer lug tiles are provided, the half the depth of joint shall be filled with polysulphide or as specified on top with under filling with cement grout without the lugs remaining exposed. The floor shall then be kept wet for 7 days. After curing, the surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

**Measurements**

Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster and the area calculated in square metre correct to two places of decimal. Where coves are used at the junctions, the length and breadth shall be measured between the lower edges of the coves.

No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre.

Areas, where glazed tiles or different types of decorative tiles are used will be measured separately.

### 1.3.5 Door / Window Joinary

**Item Description**

(i) Providing and fixing 125mm stainless steel grade 316 door handle of approved quality with necessary screws etc all complete. (Dorset or equivalent)

(ii) Providing and fixing Mortise lever handle of approved quality with necessary screws etc all complete. Dorset Edge- EDG OR SS or equivalent

(iii) Providing and fixing SS Sliding door bolts with necessary screws etc. complete:-(Dorset or equivalent)

(iv) Providing and fixing S.S. tower bolts with necessary screws etc. complete : (Dorset or equivalent)

   - Tower Bolt 250X 10mm -Modal No. TS-1010-10"
   - Tower Bolt 150 X 10 MM -Modal No. TS-1010-10"

(v) Providing and fixing Door stopper spring actuated of approved quality with necessary screws etc all complete. Modal No. DS SA(B) : (Dorset or equivalent)

(vi) Providing and fixing Door buffer -Wall mounted dia 22mm Ht. 75mm without cover (stainless steel) actuated of approved quality with necessary screws etc all complete. Modal No. DB(22) : (Dorset or equivalent)
**Sampling and Criteria for Conformity:**
The number of fittings to be selected from each lot shall depend on the size of the lot and shall be in accordance with col. 1 and 2 of Table 9.17. These fittings shall be selected at random from at least 10 percent of the randomly selected packages subject to a maximum of three equal number of fittings being selected from each such package.

1.3.6 Hermetically Sealed Double Glass

**Item Description**

(i) Providing, assembling and supplying glass panels comprising of hermetically-sealed 6-12-6 mm insulated glass (double glazed) Envision panel units of size and shape as required and specified, comprising of an outer heat strengthened float glass 6mm thick, of Neutral colour and shade with reflective soft coating on surface # 2 of approved colour and shade, an inner Heat strengthened clear float glass 6mm thick, spacer tube 12mm wide, desiccants, including primary seal and secondary seal (structural silicone sealant) etc. all complete for the required performances, as per the Architectural drawings, as per the approved shop drawings, as specified and as directed by the Engineer-in-Charge. The glass shall be assembled in the factory/workshop of the glass processor.

(ii) Providing, assembling and supplying glass panels comprising of hermetically-sealed 6-12-6 mm insulated glass (single glazed) Envision panel units of size and shape as required and specified, comprising of an outer heat strengthened float glass 6mm thick, of Neutral colour and shade with reflective soft coating on surface # 2 of approved colour and shade, an inner Heat strengthened clear float glass 6mm thick, spacer tube 12mm wide, desiccants, including primary seal and secondary seal (structural silicone sealant) etc. all complete for the required performances, as per the Architectural drawings, as per the approved shop drawings, as specified and as directed by the Engineer-in-Charge. The glass shall be assembled in the factory/workshop of the glass processor.

**Fixing**

Insulating glass shall be a double glazed unit comprising two sheets of float glass panes separated by a spacer, hermetically sealed using primary and secondary sealants. The design of insulating glass system shall consist of:

(a) **Hollow Spacer Bar**
The hollow aluminium spacer bar shall be of required size and shape and shall be colour anodized. The spacer bar shall have two lines of perforations in the inner surface.

(b) **Desiccant**
The desiccant shall be Neftomol 3 A Chemetall or equivalent. The desiccant filled in the aluminium spacer bar shall be synthesized crystalline compounds of Aluminium Hydroxide, Caustic Soda and Sodium Silicate which absorbs water molecules. The desiccant shall be of 3 A size (A means Angstrom). The quantity of desiccant used shall not be less than 35 gm/m length of spacer bar. Filled spacer bar frame shall not be stored for more than 6 hours before assembly and sealing of the unit to ensure proper functioning of the desiccant. The contractor shall submit documentary proof of using the above material in the work.

c) **Primary Sealant**
The primary sealant shall be single component approved by the Engineer in Charge, thermo plastic solvent free sealing compound based on polysosutylene. The sealant surface shall be free from cavities, depression and other defects. The contractor shall submit documentary proof of using the above material in this work.

d) **Secondary Sealant**
The secondary sealant in double glazed unit shall be silicone sealant approved by the Engineer in Charge. The contractor shall submit documentary proof of using the above material in this work to the entire satisfaction of Engineer-in-Charge.
application of silicone/polysulphide, the surface must be cleaned and free from oil,
grease, dust and other loose matter. The surfaces shall be cleaned with alcohol or
other suitable solvents. Detergent or soap shall not be used to clean the surfaces.
The polysulphide shall be mixed and applied mechanically using automatic mixing
machine in the manner approved by Engineer-in-Charge.

**Measurement**
The height and width of double glazed/single glazed unit (the area of glass unit
outside the snap beading shall only be measured) as fixed in place shall be
measured correct to one centimeter and area calculated in sqm. correct to second
place of decimal shall be taken for payment.

### 1.3.7 Exterior Grade Vitrified Tiles

**Item Description**
Providing and laying EXTERIOR GRADE VITRIFIED TILES in different sizes
(thickness to be specified by the manufacturer) with water absorption less than
0.08% and conforming to IS: 15622, of approved make, in all colours and shades,
laid on 20mm thick cement mortar 1:4 (1 cement : 4 coarse sand), jointing with grey
cement slurry @ 3.3 kg/ sqm including grouting the joints with white cement and
matching pigments etc., complete.

**Fixing**
Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned,
wetted and mopped. The bedding for the tile shall be with cement mortar 1:4 (1
cement : 4 coarse sand) or as specified. The average thickness of the bedding shall
be 20 mm or as specified while the thickness under any portion of the tiles shall not
be less than 10 mm.

Mortar shall be spread, tamped and corrected to proper levels and allowed to harden
sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the
mason to place wooden plank across and squat on it.

Over this mortar bedding neat grey cement slurry of honey like consistency shall be
spread at the rate of 3.3 kg of cement per square metre over an area upto one
square metre. Tiles shall be soaked in water washed clean and shall be fixed in this
gROUT one after another, each tile gently being tapped with a wooden mallet till it is
properly bedded and in level with the adjoining tiles. The joints shall be kept as thin
as possible and in straight lines or to suit the required pattern.

The surface of the flooring during laying shall be frequently checked with a straight
edge about 2 m long, so as to obtain a true surface with the required slope. In bath,
toilet W.C. kitchen and balcony/verandah flooring, suitable tile drop or as shown in
drawing will be given in addition to required slope to avoid spread of water. Further
tile drop will also be provided near floor trap.

Where full size tiles cannot be fixed these shall be cut (sawn) to the required size,
and their edge rubbed smooth to ensure straight and true joints. Tiles which are fixed
in the floor adjoining the wall shall enter not less than 10 mm under the plaster,
skirting or dado.

After tiles have been laid surplus cement slurry shall be cleaned off.

**Measurements**
Length and breadth shall be measured correct to a cm before laying skirting, dado or
wall plaster and the area calculated in square metre correct to two places of decimal.
Where coves are used at the junctions, the length and breadth shall be measured between the lower edges of the coves.

No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre.

Areas, where glazed tiles or different types of decorative tiles are used will be measured separately.

1.3.8 uPVC SWR Pipes

**Item Description**
Providing and fixing on wall face unplasticised SWR PVC pipes confirming to IS:13592 Type A including jointing with seal ring confirming to IS:5382 leaving 10 mm gap for thermal expansion. (I)single socketed pipes - 150 mm dia

Pipes shall conform to Type A pipes of IS 13592. The internal and external surfaces of the pipes shall be smooth and clean and free from groovings and other defects. The end shall be clearly cut and shall be square with the axis of the pipe. The end may be chamfered on the plain sides. Slight shallow longitudinal grooves or irregularities in the wall thickness shall be permissible provided the wall thickness remains within the permissible limit.

**Fixing**
Pipes shall be either fixed on face of wall or embedded in masonry as required in the description of the item.

Plain pipes shall be secured to the walls at all joints with PVC Pipes clips by means of 50 x 50 x 50 mm hard wood plugs, screwed with M.S. screws of required length i/c cutting brick work and fixing in cement mortar 1:4 (1 cement : 4 coarse sand). The clips shall be kept about 25 mm clear off finished face of wall, so as to facilitate cleaning of pipes. Pipes shall be fixed perfectly vertical or to the lines as directed.

The pipes shall be fitted to fittings with seal ring conforming to IS 5382 allowing 10 mm gap for thermal expansion.

**Measurement**
The pipes shall be measured in Mtr net when fixed correct to a cm. excluding all fittings along its length.

1.3.9 uPVC SWR Fittings

**Item Description**
(i) Providing and fixing on wall face unplasticised uPVC SWR moulded fitting accessories for unplasticised Rigid PVC pipes confirming to IS-13592 type A including jointing with seal ring confirming to IS 5382 leaving 10mm gap for thermal expansion. - Coupler (socket)150 mm dia

(ii) Providing and fixing on wall face unplasticised uPVC SWR moulded fitting accessories for unplasticised Rigid PVC pipes confirming to IS-13592 type A including jointing with seal ring confirming to IS 5382 leaving 10mm gap for thermal expansion. - Plan Bend (with door 150 mm)

(iii) Providing and fixing unplasticised -PVC pipe clips of approved design to unplasticised - PVC rain water pipes by means of 50x50x50 mm hard wood
plugs, screwed with M.S. screws of required length, including cutting brick work and fixing in cement mortar 1:4 (1 cement : 4 coarse sand) and making good the wall etc. complete. - PVC pipe bat clamp 150mm dia

**Fixing**
Fittings used shall be of the same make as that of the PVC pipes Injection moulded or fabricated by the manufacturer and shall have a minimum wall thickness of 3.2 mm. The fittings shall be supplied with grooved socketted ends with square grooves and provided with Rubber Gasket conforming to IS 5382. The plain ends of the fittings should be chamfered. The fittings shall be joined with the help of Rubber lubricant. The details of fittings refer IS 13592.

**Measurement**
The fittings shall be measured by numbers. The pipes shall be measured net when fixed correct to a cm. excluding all fittings along its length.

### 1.3.10 Paints Work

**Item Description**
(i) Finishing walls with Exterior Emulsion low VOC (weatherproof and dirt resistant) Apex Ultima having Low VOC content of approved brand and manufacture, including applying additional coats wherever required to achieve even shade and colour.
(ii) Finishing walls with Interior Acrylic Emulsion low VOC (premium) Apcolite Premium Emulsion having Low VOC content of approved brand and manufacture, including applying additional coats wherever required to achieve even shade and colour.
(iii) Finishing walls with Royale Play Mettalics Texture Paint of approved brand and manufacture, including applying additional coats wherever required to achieve even shade and colour.

**Specifications**
All material required for the works shall be of specified and approved manufacturer, delivered to the site in manufacturer’s containers with the seals etc., unbroken and clearly marked with the manufacturer’s name or trade mark with a description of the contents and colour. All materials are to be stored on the site of the work.

Spray painting with approved machines will be permitted only if written approval has been obtained from the client/consultant prior to painting. No spraying will be permitted in the case of priming coats or where the soiling of adjacent surface is likely to occur. The nozzle and pressure to be so operated as to give an even coating throughout to the satisfaction of the client/consultant. The paint used for spraying is to comply generally with the specification concerned and is to be specially prepared by the manufacturer for spraying. Thinning of paint by brushing will not be allowed.

Wood preservation shall be Solignum or other equal and approved impregnating wood preservative and all concealed woodwork shall be treated with wood preservative and anti-termite treatment with Termiseal or equivalent chemical.

All brushes, tools, pots, kettles etc., used in carrying out the work shall be clean and free from foreign matter and are to be thoroughly washed out before being used with a different class of materials.
All iron or steel surfaces shall be thoroughly scraped and rubbed with wire brushes and shall be entirely free from rust, mill scale, etc., before applying the primary coat. Surfaces of new woodwork to be painted are to be rubbed down and cleaned to the approval of the client/consultant.

**Measurement**

The length and breadth shall be measured correct to a cm. The area shall be calculated in sqm (correct to two places of decimal), except otherwise stated.

Small articles not exceeding 10 sq. decimetre (0.1 sqm) of painted surfaces where not in conjunction with similar painted work shall be enumerated.

Painting upto 10 cm in width or in girth and not in conjunction with similar painted work shall be given in running metres and shall include cutting to line where so required.

1.3.11 Aluminium Door / Window Joinary (Fittings)

**Item Description**

(i) Providing and fixing aluminium handles, ISI marked, anodised (anodic coating not less than grade AC 10 as per IS : 1868) transparent or dyed to required colour or shade, with necessary screws etc. complete - 100 mm

(ii) Providing and fixing aluminium tower bolts, ISI marked, anodised (anodic coating not less than grade AC 10 as per IS : 1868) transparent or dyed to required colour or shade, with necessary screws etc. complete:

(iii) Providing and fixing aluminium casement stays, ISI marked, anodised (anodic coating not less than grade AC 10 as per IS : 1868) transparent or dyed to required colour and shade, with necessary screws etc. complete.

**Sampling and Criteria for Conformity**

The number of fittings to be selected from each lot shall depend on the size of the lot and shall be in accordance with col. 1 and 2 of Table 9.17. These fittings shall be selected at random from at least 10 percent of the randomly selected packages subject to a maximum of three equal number of fittings being selected from each such package.

1.3.12 Wooden False

**Item Description**

Providing and fixing false ceiling at all height including providing and fixing of frame work made of special sections, power pressed from M.S. sheets and galvanized with zinc coating of 120 gms/sqm (both side inclusive) as per IS : 277 and consisting of angle cleats of size 25 mm wide x 1.6 mm thick with flanges of 27 mm and 37 mm, at 1200 mm centre to centre, one flange fixed to the ceiling with dash fastener 12.5 mm dia x 50mm long with 6mm dia bolts, other flange of cleat fixed to the angle hangers of 25x10x0.50 mm of required length with nuts & bolts of required size and other end of angle hanger fixed with intermediate G.I. channels 45x15x0.9 mm running at the spacing of 1200 mm centre to centre, to which the ceiling section 0.5 mm thick bottom wedge of 80 mm with tapered flanges of 26 mm each having lips of 10.5 mm, at 450 mm centre to centre, shall be fixed in a direction perpendicular to G.I. intermediate channel with connecting clips made out of 2.64 mm dia x 230
mm long G.I. wire at every junction, including fixing perimeter channels 0.5 mm thick 27 mm high having flanges of 20 mm and 30 mm long, the perimeter of ceiling fixed to wall/partition with the help of rawl plugs at 450 mm centre, with 25mm long dry wall screws @ 230 mm interval, including fixing of gypsum board to ceiling section and perimeter channel with the help of dry wall screws of size 3.5 x 25 mm at 230 mm c/c, including jointing and finishing to a flush finish of tapered and square edges of the board with recommended jointing compound, jointing tapes, finishing with jointing compound in 3 layers covering upto 150 mm on both sides of joint and two coats of primer suitable for board, all as per manufacturer's specification and also including the cost of making openings for light fittings, grills, diffusers, cutouts made with frame of perimeter channels suitably fixed, all complete as per drawings, specification and direction of the Engineer in Charge but excluding the cost of painting with - 1mm thick laminate over 9mm thick MDF Board

**Fixing Frame Work**

The frame work shall be suspended from ceiling by level adjusting hangers made of 6 mm dia. M.S. rods fixed to slab by means of MS ceiling cleats. The ceiling cleats shall be fixed to the slab by means of mechanical dash fasteners 6 mm dia and 50 mm long. MS hangers and ceiling cleats shall be painted with a coat of yellow zinc chromate primer and two coats of synthetic enamel paint.

**Board**

The outer lines of boards shall be accurately fixed, parallel and close to the wall. Each subsequent plank shall be carefully jointed up. The boards shall be fixed to the frame scantling above with two screws at each of frame and one at every intermediate joist. The screws shall be counter sunk and the screw holes filled with putty or sloping out wax.

**Measurement**

Length and breadth shall be measured correct to a cm. Areas shall be worked out to nearest 0.01 sqm. The superficial area of the finished work ceiling shall be measured in square metres.

No deduction in measurements shall be made for openings of areas upto 40 square decimetre.

Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.40 sqm in area, deductions in measurements for the full opening will be made and in such case any labour involved in making these openings shall be paid for separately in running metres.

Wooden ceiling of boardings fixed to curve surfaces in narrow widths shall be measured and paid for separately and shall include making the joints to proper splay.

Circular cutting and waste shall be measured and paid for separately in running metres.

**1.3.13 Wall Paneling**

**Item Description**

Providing and fixing in wall lining MDF Board IS: 14587:1998 marked, laminated one side decorative lamination and other side balancing lamination, with necessary fixing arrangement and screws etc. complete.
Fixing
Grounds shall be provided where so specified. These shall consist of first class hard wood plugs or the class of wood used for fabricating the frames, of trapezoidal shape having base of 50 × 50 mm and top 35 × 35 mm with depth of 5.0 cm and embedded in the wall with cement mortar 1:3 (1 cement : 3 fine sand) and batten of first class hard wood or as specified of size 50 × 25 mm or as specified, fixed over the plugs with 50 mm long wood screws. The plugs shall be spaced at 45 to 60 centimetres centre to centre, depending upon the nature of work. The battens shall be painted with priming coat, of approved wood primer before fixing.

The MDF shall be painted on the back with priming coat of approved wood primer before fixing the same to the grounds with screws, which shall be sunk into the wood work and their tops covered with putty. The panelling work shall be made true and accurate to the dimensions shown in the working drawings. The fixing shall be done true to lines and levels. The board for wall lining shall be tongued and grooved, unless otherwise specified.

Measurement
Length and breadth shall be measured correct to a cm. Wall panelling such as teakwood panelling and block panelling, plain lining, and plain skirting each shall be measured separately in square metre nearest to two places of decimal. The moulded work shall be measured in cm running metre i.e. in running metres stating the girth in cm. The sectional periphery (girth) of moulding excluding the portion in contact with wall shall be measured in cm correct to 5 mm and length in metre correct to a cm.

The measurements for ground shall be taken on the basis of cubical contents of battens and paid for separately, unless otherwise specified. Where only plugs are required to be fixed for the panelling work, the cost for the same shall be deemed to be included in the rate of panelling work and no separate payment shall be made for plugs.

1.3.14 Polycarbonate Sheet Roofing

Item Description
Providing and fixing 10mm thick clear multi wall polycarbonate sheets of approved quality and shade in desired shape in roofing including cost of EPDM gaskets, sealing tape, 50 or 60mm aluminium profile and all necessary accessories fixed to existing MS tubular frame work complete as per architectural drawings and as directed by Engineer in charg. The item included designing the complete system, supplying and getting approval from client. Detailed shop drawings including supplying structural desing calculation based on relevant codal provisions carrying out water penetration test as per standard followed in India. Cost of MS frame work to be paid seperatly.

Fixing
As per manufacturer specifications and standard engineering practices.

Measurement
Length and breadth shall be measured correct to two places of decimal, measurement shall be taken over the entire exposed area of roof.

1.3.15 Geo Textile Membrane

Item Description
Providing & fixing Geotextile separation membrane, 120gms non woven, 100% polyester of thickness 1 to 1.25 mm.

**Fixing**
Geotextile 120 gm. Non woven 100% polyester of thickness 1.0 to 1.25 mm manufactured by a company of repute shall be used.

Geotextile of the specified thickness is bonded to the layer of P.C.C. with intermittent touch by heating the membrane by Butane torch as per manufacturing recommendations.

**Measurement**
Length and breadth shall be measured correct to two places of decimal, measurement shall be taken over the entire exposed area slab.

1.3.16 Water proof surface coat

**Item Description**
Application of NITIBOND EP (or equivalent product as approved) surface coat at the junction of old and new plaster as per manufacturer's recommendations for proper bonding of the plaster to wall surface.

**Measurement**
Length and breadth shall be measured correct to two places of decimal, measurement shall be taken over the wall/column/beam surface area under application.
SCOPE OF WORK

(Part- II)

PLUMBING AND FIRE FIGHTING WORK
1. Scope of Work for Plumbing and Fire Fighting Works

1.0 SCOPE OF WORK

1.1 The scope of work for the Equipments & Materials of Plumbing & Fire Fighting System shall be as per the following details. The Scope of work for Plumbing and Fire Fighting Works, shall include execution of all following works but not limited to these scope of works.

1.1.1 The Plumbing
- Water treatment process from raw water to potable water if required.
- Storage Tanks of potable water & non potable water
- Potable water storage tank will be pumped to overhead water tank through two sets of VFD pumps one will be working & other will be Stand by.
- Internal water supply including Hot & Cold
- Sanitary ware & Water conservation using low flow Fixtures fittings.
- Hot water supply System
- Internal Soil, waste and rain water pipes disposal to 1st manhole
- Disposal to external sewerage system to proposed STP
- Storm Water Drainage System
- Rain water harvesting for recharging aquifer and disposal of surplus storm water to nearby existing drain.
- Garden Hydrant system consisting pumps, piping and hydrants
- Hot water generator & allied system
- Solid Waste/Waste Water Management

1.1.2 Fire Fighting work shall include
- Static water storage tanks
- Downcomer connected to hose reel
- 2 way fire brigade inlet at groud floor
- Terrace Fire Pumps & Accessories
- Portable Fire extinguishers
- Clean agent suppression system if required
- Sanction of Plans from local fire authorities
- Completion certificate from local fire office

1.2 General
The special conditions of contract given below shall be read in conjunction with the other documents forming part of the contract. In case of any variance, these conditions shall supersede any other conditions mentioned in any contract document.

The materials, design and workmanship shall satisfy the specifications contained herein and codes referred to. Where the technical specifications stipulate the requirement in addition to those contained in the Standard Codes and specifications those additional requirements shall also be satisfied. In the absence of any Standard / Specifications covering any part of the work covered in this tender document, the instructions / directions of engineer-in-charge will be binding on the contractor.

All Plumbing & Fire Fighting installations shall be of high quality, complete and dully operational including all necessary items and accessories whether or not specified herein. All Plumbing & Fire Fighting work shall be completed in accordance with the regulations and standard to the satisfaction of the Engineer-in-charge.

1.3 Technical Requirement of Submission of Tenders

The followings technical documents shall be submitted during the submission of the tender:

i) Complete Design Basis Report with Selected Equipment Capacity and Configuration in compliance with the Tender Documents.

ii) Water demand calculations for all areas to be as per NBC 2016 as given in the basis of design in the tender with the equipment selected & offered by you based on the tender.

iii) Deviations / Assumptions, if any from Tender specifications.

iv) Complete technical particulars of all equipments and materials.

v) A set of technical leaflets and selection charts for all the equipments offered.

Bidder should clearly mention the Make of Equipments from the approved makes for each equipment they wish to offer and must furnish full technical data for the each make separately.

1.4 Shop Drawings

On the award of the work, the Contractor shall immediately proceed with the preparation of detailed working drawings showing the detail of each equipment that are to be installed and the ancillary works that are to be carried out. All the works are deemed to be included in various items of bill of quantities as applicable.

Three sets of all such working drawings dully signed by the head of the planning & design department of the tenderer shall be submitted to the Engineer-in-charge for approval to ensure that the works will be carried out in accordance with the specifications and drawings, including such changes as may have been mutually agreed upon. All the drawings shall be received by the Engineer-in-charge for approval within 04 (Four) weeks from the date of award of work. The approval of the drawings by the Consultants / Engineer-in-charge shall in no way relieve the Contractor form his obligations to provide a complete and satisfactory plant installation, testing and commissioning as per intent and purpose as laid down in the specifications. It will be the responsibility of the Contractor to ensure that laid down inside conditions are maintained at all times.
Any omissions and / or errors shall be made good or rectified whether or not the drawings are approved. Contractor shall obtain written approval for samples (like toilet details / pipe supports) and other materials before placing the order. Contractor shall guarantee the specified inside conditions at specified outside conditions. Prior to the erection of Equipments, the contractor shall furnish to the employer (2) two sets of a comprehensive manual for all equipments etc. describing all components furnishing a list of spare parts and setting forth in details the instructions for the operation and maintenance of the plant.

The Contractor shall also fix in the Operating / Maintenance Room, neatly typed and framed instructions in details, for the starting and running of the plant.

The Contractor for approval shall prepare the following shop drawings:

a) Plumbing & Fire Fighting Tanks and Plant Room Equipment Layout along with sectional drawings of each installed equipment.
b) Schematic water supply / fire fighting water piping layout, pipe support details drawing showing the level of pipes.
c) Plumbing & Fire fighting layout plans of all floors with sections, support details, position of pipes / equipment etc.
d) Plumbing & Fighting equipments foundation layout plans and load data.
e) The Main Plumbing & Fighting Electrical Panel power & control wiring drawings.
f) Water Supply Schematic & floor plan drawings in detailed with logics of operations.
g) Electrical power requirements of all Plumbing & Fire Fighting Equipments on equipment Layout Plans along with Summary in Excel Format.
h) Individual equipment drawings from equipment manufacturer along with technical data sheets. (For Engineer-in-Charge / Consultant’s Approval)

Any other shop drawings necessary for the project and required by client team such as Architects / Consultant.

1.5 As Built Drawings
The Contractor shall submit six sets of paper prints of the as-built drawings & one soft copy, showing accurate record of the work as installed to the Client for his reference. The contractor shall also submit three copies of an Operating Manuals in ring binder describing the brief write up on the system installed, operating instruction for all equipments, catalogues, maintenance of equipments etc.

1.6 Instruction / Maintenance Manual
The Contractor shall prepare and produce instruction, operation and maintenance manuals in English for use, operation and the maintenance of the supplied equipment and installations, and submit to the Engineer-in-charge in three copies at the time of handing over. The manual shall generally consist of the following:

a) Description of the Project.
b) Operating instructions.
c) Maintenance instructions including procedures for preventive maintenance.
d) Manufacturers catalog.
e) Spare parts list.
f) Trouble shooting charts.
g) Drawings.
h) Type and routine test certificates of major items.

Six sets of as built drawings along with soft copy of drawings in CD.

1.7 Performance Bound Contract
The contract will be a performance bound contract and therefore the Bidder shall make their independent check for water demand sheet, selection of equipments etc. The drawings enclosed with the tender documents shall be only tentative layout plans and for guidance purpose only. The detailed shop drawings shall be prepared and submitted for approval to the Department / Engineer-in-Charge / Consultant.

The Contractor shall guarantee the specified inside condition at specified outside condition considering the fresh air as detailed in the basis of design of the tender documents.

The contractor shall guarantee that the capacity of various equipments as well as the whole system shall be within ± 3% of the specified capacity.

1.8 Guarantee
The Contractor shall guarantee the inside design conditions as stipulated. The Contractor shall be responsible for maintaining the desired inside conditions with the equipments selected & offered by him and shall not deprive him of the responsibility if selection of equipment given in the tender document is not thoroughly checked. In case of shortfall the Contractor shall replace / modify equipment for achieving desired parameter without any extra cost to Department / employer. The contractor would be bound to replace the equipment / equipments selected by him if design condition is not achieved by the Plumbing & Fire Fighting System offered & installed by him. The contractor shall guarantee the complete Plumbing & Fire Fighting system for a period of 12 months from the date of handing over all the works in all respect after successful commissioning. They shall also guarantee that the performance of the various equipments individually / jointly shall not be less than the specified ratings when working under operating conditions for the complete installation.

1.9 Repairs / Replacement of Parts during Guarantee
Any defects or other faults which may appear within defect liability / guarantee period of twelve months from the date of handing over in a satisfactory working conditions to the Department (except for normal wear and tear) arising in the plant from material or workmanship not in accordance with the contract specification will be rectified by the Contractors free of cost & nothing shall be paid extra on any account. The Contractor shall handover all the Guarantee/ Warranty certificates of the items/ equipments with warranty/ Guarantee period of over 1 Year to the EPIL at the time of handover.

Complaints: - The contractor shall receive all calls for any or all problems experienced in the operation of the system under this contract & shall attend these within 24 Hours of receiving the complaints & shall take steps to immediately correct any deficiencies that may exist.

1.10 Quiet Operation & Vibration Isolation of Plumbing & Fire Fighting System
All Plumbing & Fire Fighting equipments shall operate under all varying / part load conditions without any objectionable sound or vibration as specified in the section Noise & Vibration Control or in the opinion of the Department / consultant. In case of rotating machinery sound or vibration noticeable outside / inside the room in which it is installed shall be considered objectionable & shall be rectified by the Contractor at his own expense up to the satisfaction of consultant / Department.

1.11 Testing
All testing instruments, velocity meter, digital / electronic electric energy meter, digital thermometer, pyschrometer, measuring steel tapes, tools, scaffolding and ladders etc., that may be required for taking measurements shall be arranged by Contractor at his own cost.

All types of specified & routine tests of the equipments shall be carried out at the works of the Contractor or the manufacturers of the components. The Department shall be free to witness any or all tests, if they so desired and cost of the same in all respect shall be beared by the Contractor. The Contractor has to inform to the Client before dispatch of any material / equipment.

On the completion of the installation, the Contractor shall arrange to carry out various initial tests as detailed below, in the presence of and to the complete satisfaction of the Department / Engineer-in-Charge / Consultants, any defect or short-coming found during the tests shall be speedily rectified or made good by the Contractor at his own expenses. The initial tests shall include, but not be limited to the following:

a) To operate and check proper functioning of all electrically operated components viz. Compressor motor, pumps units etc. as well as other electrical motors.
b) To test and check the proper functioning of electrical gears, safety and other controls to ensure their proper functioning.
c) To check the water, sewerage & storm water etc distribution system and to provide designed water & sewer in all.
d) To check & balance / adjust the water in the circuit for smooth and noiseless flow.
e) To check the systems against leaks in different circuits, alignment of motor, 'V' belt adjustments, control setting and all such other tests which are essential for smooth functioning of the plant.
f) Contractor shall have to submit the capacity test of all equipment at site.
g) On the satisfactory completion of all 'Initial' tests the plant shall be considered 'Virtually Complete' for the purpose of taking over by the Client.

It is clarified that guarantee period shall start after successful completion of commissioning & handing over the project along with all the components together in all respect.

1.12 System Balancing

The Contractor shall leave the system operating in complete balance with water and sewerage quantities as shown on approved drawings. Set stops on all valves and in proper position. Secure all automatic damper and valve linkage in proper positions to provide correct operating ranges.

1.13 Operation of Plant

The tenderer shall arrange to operate for a period of ONE MONTH from the date of commissioning and successful completion of initial test free of cost.

1.14 Training of Personal

The Contractor shall impart training to the minimum three technical staffs appointed by the client free of cost during erection and commissioning of the plant.

1.15 Inspections & Testing

All the major equipments may be got inspected & tested before dispatch if desired by the client at the manufacturers work , and cost of the same in all respect shall be beared by the Contractor.
The Contractor shall intimate the client minimum 21 days in advance about the date of readiness of equipment for inspection & testing at a date to be mutually agreed upon by the client & the Contractor.

The manufacturer of these equipments must have a facility of testing the equipments at the test bed on full load at their works. All the test readings mutually taken shall be recorded & evaluated with the technical data furnished by the Contractor.

1.16 Storage of Materials / Equipments
Contractor shall make their own arrangement for storage of materials / equipment brought to site. Watch and ward of the same shall be the Contractor's responsibility.

1.17 Insurance
The Contractor shall be responsible for the storage and safe custody of all equipment / materials brought to site from time to time till the plant is taken over by the Department. The Contractor is to provide adequate and comprehensive insurance coverage for storage and execution.

The Contractor shall be responsibility for all the injury or damage to persons, buildings, structures, property etc., which may arise form any act of omission on part of the Contractor of his servants or sub contractors or his employee etc. The Contractor shall indemnify and keep indemnified the Department and hold him harmless in all respects of all and any expenditure liability, loss, claims or proceeding arising from any such injury or damage to persons or property as aforesaid.

The Contractor shall undertake all risk policy including earthquake risk with an insurance company approved by the Department in the joint names of Department and contractor at his own expense.

The minimum limits of coverage in the policies shall be as follows:

a) Transit and Storage insurance cover for full amount of the contract.
b) Against damage to existing property and to new works full to reinstate all damages and claims for damage to property to third parties.

The Contractor shall also indemnify the Department against all claims which may be made by the Department, whether under the workman compensation Act or any other statute in force during the currency of this contract or at common law in respect of any employee of the Contractor or subcontractor and shall at his own expense maintain under the completion of contract, with the insurance company approved by the Department, a policy or policies and deposit these with the Department from time to time during the currency of this contract. The insurance cover shall be in the joint names of the Department and the contractor (The name of the Department shall come first).

The Contractor shall be responsible for any liability which may not be covered by the insurance policies referred to the above and all other damages to any person or property etc. arising out of an incidental to the negligent or fault execution of this contract, whatever may be reason due to which the damage shall have been caused.

The Contractor shall also indemnify and keep indemnified the Department against all and any cost, charges or expenses arising out of any claim or proceedings relating to the works and also in respect of any awards of damages or compensation arising there from without prejudice to the other right of the Department against the Contractor in respect of such default, the Department shall be entitled to deduct from any sum payable to the
contractor the amount of any damage, compensation, costs, charges and other expenses paid by the Department and which are payable by the contractor under this clause.

The provision contained within this article are not intended and do not impair or in any manner limit the liabilities or obligations assumed by the Contractor as may be set forth move fully elsewhere in this agreement.

1.18 Comprehensive Annual Maintenance

Periodical checking for all parameters for machines operation and diagnosis, routine checking and cleaning operations, annual preventive maintenance / overhauling as required for smooth and trouble free operation of the package shall be carried out by the Contractor. The Contractor shall furnish detailed facilities available with him for executing such contract and also furnish annual charges for the same in the priced part of the Bid. Rates shall be quoted in the Price Bid only.

2.0 DESIGN SCOPE & OBJECTIVE

Scope of Work

The scope of Plumbing & Fire Fighting document is to highlight proposed design for the following services based on the Internal & External infrastructure.

a) Plumbing works shall include;
   • Source of water supply
   • Water treatment process from raw water to potable water if required
   • Storage Tanks of Raw water, potable water & non potable water Potable water storage tank will be pumped to overhead water tank through two sets of VFD pumps one will be working & other will be Stand by.
   • Internal water supply including Hot & Cold
   • Sanitary ware & Water conservation using low flow Fixtures fittings.
   • Hot water supply System
   • Internal Soil, waste and rain water pipes disposal to 1st manhole
   • Disposal to external sewerage system
   • Storm Water Drainage System
   • Rain water harvesting for recharging aquifer and disposal of surplus storm water to nearby Authority drain.
   • Garden Hydrant system consisting pumps, piping and hydrants
   • Hot water generator & allied system
   • Solid Waste/Waste Water Management

b) Fire Fighting works shall include;
   • Static water storage tanks
   • Terrace Fire Pumps & Accessories
   • Hose reel & fire hydrants
   • Downcomer
   • Portable Fire extinguishers
   • 2 way fire brigade inlet at ground floor.
3.0 BASIS OF DESIGN

3.1 Efficient Energy Measures

3.1.1 Reduce water use in building:
- Water Efficient fixtures (low flush toilets, dual flush adaptors, low flow flush valves etc)
- Auto-control valves (sensor taps, self operating valves etc)
- Pressure reducing device (aerators, flow regulators etc)

3.1.2 Reduce landscape water requirement:
- Reduce lawn area (avoid evaporation loss of water)
- Drip Irrigation (deep percolation & avoid evaporation / run-off)
- Sprinkler Irrigation (uniform distribution, high infiltration rate)

3.1.3 Efficient water use during construction:
- Use material such as pre-mixed concrete
- Use recycled treated water
- Control the waste of curing water

3.1.4 Water recycles & reuse:
- Rain water harvesting system & storage system
- Recharge the surplus water (after reuse) in to aquifer

3.1.5 Renewable-energy-based hot-water system:
- Meet 20% or more of the annual energy as per ECBC NORMS required for heating water through renewable energy. Based water-heating system.

3.2 Detailed Design Basis

3.2.1 Introduction
- Type of the Buildings: Office, etc.
- Max height of Building: Category: Less than 10 mtr
- Categories as per NBC: Business buildings

Note: Norms may be finalized as per final Architectural building section height.

3.2.2 Code & Regulation
Plumbing/Sanitary systems will be designed and installed conforming to the following codes and standards:
- Regulations of the local authority.
- National Building Code (NBC) 2016
- Manual on water supply and treatments published by Central Public Health and Environment Engineering Organization Ministry of Urban Development, Govt. of India.
- Relevant BIS Codes.
- Good Engineering Practice.
3.3 Design Brief

The Plumbing services for the project shall be designed keeping in view the following:

i. Requirement of adequate and equal pressure of cold water in toilets, kitchens and other designated areas. Cold water makeup supply to water bodies shall be ensured.

ii. Adequate storage of raw water/domestic water in underground water tanks (for one day requirement) for all building. Further static water storage for firefighting requirement shall also be provided based on NBC requirements and as required by local Chief Fire Officer. Separate underground fire tanks & fire pumps shall be provided as per local fire officer’s requirement.

iii. Recycling of treated waste water (from sewage treatment plant) for flushing, Cooling Tower makeup and for irrigation water use.

3.4 Total Water Requirement for Building

The water requirement as per I.S. specifications, Govt. manuals and general practice for buildings shall be as per following:

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<th>S.No</th>
<th>Name of the Item</th>
<th>Area (In SqFt)</th>
<th>Population</th>
<th>Requirement in LPCD as per NBC-2016</th>
<th>Total in LPCD</th>
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<td></td>
<td></td>
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<td>Domestic Supply (Per Person)</td>
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<tr>
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<td>TOTAL LOAD IN Cum/Day</td>
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<td>10.00</td>
</tr>
</tbody>
</table>

3.0 Fire Fighting (Static Water Storage)

3.1 Under ground (As per NBC-2016)  
NR

3.2 Over head (As per NBC-2016)  
10000.00

4.0 Underground Water Tank Capacity

4.1 Domestic  
15000.00

5.0 Overhead Water Tank Capacity

5.1 Domestic (Approx)  
5000.00

5.2 Fire (Static)  
10000.00

5. Total  
15000.00

3.4.1 Source & Treatment

Water will be sourced from the following source:-
3.4.2 Quality of Water, Pumping, Overhead Storage & Distribution System

Quality of Water Supply

Since, the water will be required for different uses; also it has to be of a required standard quality. Therefore treatment of water is recommended, depending upon the results obtained from different analytical examinations of the samples of water, taken from the proposed sources. It is also advisable to maintain a strict monitoring system on the quality of the water during the operation of the system.

Depending upon the analysis of water available, specific treatments shall be suggested. However the water shall be passed through filter (ACF & DMF), softener and shall be chlorinated prior to the supply for the building users.

Desirable quality of Domestic water as per standards lay down follows:

- **Hardness**: < 100 mg/l
- **Total dissolved salts**: Less than 500 mg/l Extendable up to 1000 mg/l

**a) Water Supply System**

i. **Drinking Water**
   
   Provision will be made to install water treatment plant in pump room.

ii. **Flushing Water**
   
   Since there is no recycled water from STP, an independent system of pumps, pipes and overhead tank for raw water on terrace shall be provided. This water shall be used only for flushing and ablution taps/health faucets.

   Pumping system is proposed for flushing water system by gravity system and since the pressure in the lower floors shall be high, pressure reducing valves shall be provided to maintain reasonable pressure.

   An O.H. tank (raw water) as per requirement & mechanically floated operated valve.

iii. **Water for Irrigation/ Horticulture/Road washing**

   Water to the garden hydrants shall be supplied through a separate garden pump, which shall be supply water from Another set of pump will be provided near raw water tank in plant room for fill the treated sewage water tank whenever the sewage flow is low. Operation of these pumps shall be manually operated system.

iv. **Water body makeup water**

   For water body separate filtration plant & balancing tank will be proposed and supply makeup water from there.

**b) Water Distribution**
Pipe sizing shall be based on fixture unit calculation as per ASPE standard. However, the maximum velocity in the water supply piping shall not exceed 2.4 m/second. Water meters shall be provided in identified areas for water consumption recording for efficient monitoring and assessment. Color coding for flushing water supply piping shall be ensured for clear identification of the piping.

c) Location & Area requirements for Plant Room & Storages

The U.G. water tanks shall be located separately as marked in the drawing by the Architect and the Plumbing & Fire Fighting plant room shall be adjacent to underground tank. The plant room has fire pumps, water supply pumps, water treatment plant and all other related equipment located there. These services shall act as a centralized system for buildings.

d) Materials for Water Supply

- All external pipe in trench & in shaft / terrace level shall be GI heavy duty conforming to IS (IS 1239 up to 150 mm dia. and IS3589 above 150 mm dia.).
- For internal works, the pipes running at the ceiling level and then dropping down in chases to the various fixtures will GI pipes (class B).
- Valves on branches, main line and pumps shall have ball valve/gate valve/butterfly valve of good approved quality, as per requirement.

3.5 Sewerage System

3.5.1 Sewerage System

There are two type of waste 1st Soil waste from toilets, urinals i.e. domestic waste and etc. will be collected by horizontal and vertical soil pipes and discharged separately to the manholes. Wastes from wash basins, sinks, and from other waste fixtures shall be collected separately by waste pipes and be discharged through gully traps into the manhole of the external sewerage system.

The external sewerage system shall be running around the building periphery having manholes in front of each shaft. The main sewer line will carry the whole sewage by gravity up to the Sewage Treatment Plant and the excess treated water from STP will be thrown to the ultimate Municipal disposal point of the building and treated water.

Considering the latest environmental laws from the pollution and environmental agencies and also considering that hazardous materials for disposal from different components, it is suggested to provide a Package type Sewage Treatment Plant for domestic waste of 80 m³/day approx. capacity, whose design is based on a scientific system.

3.5.2 Sewerage Disposal

The meaning of efficient sewerage disposal system is slowly changing due to increase of water-demand and continuous depletion of underground water resources with the development of civilization in the coming future. Earlier it was limited only to the
collection of different wastes to the nearest manhole through external sewer lines and ultimate disposal to either main municipal sewer line or septic tank and soak pits in case municipal lines did not exist.

3.5.3 Grease removal unit

The grease removal unit shall be a separate and independent unit comprising of a holding tank, solid waste crusher, a water cooled paddle type grease separation chamber with air diffusion system, a PVC bin to collect the grease to be installed.

3.5.4 Material Specifications for the Sewerage System

- **SW Pipes**
  For dia. 100mm, 150mm and 200mm Grade ‘A’ as per IS:651 depending on site conditions with laying, jointing and bedding as per IS:4127-1983

- **RCC Pipes Class NP2**
  For dia. 250mm and above as per IS: 458, for normal slopes and general site conditions.

3.5.5 Manholes

The manholes shall be constructed of brick masonry as per standard specifications of National Building Code and shall be having details as follows:

- Rectangular of size 900x800mm up to 900mm depth.
- Circular of size 910mm dia from 900mm up to 1670mm depth.
- Circular of size 1220mm dia from 1668mm up to 2290mm depth.
- Circular of size 1520mm dia from 2290mm up to 4180mm depth.
- Manhole Covers
  Steel fiber reinforced concrete (SFRC) Manhole cover with frame conforming to IS: 12592 shall be provided.

3.6 Drainage & Rain Water Harvesting System

3.6.1 Introduction

Due to urbanization of the land and sharp growth in population and thus increase in water demand for various uses, the fresh water is becoming scarce in most regions of the area. In certain areas due to almost total dependency on the underground water, the wells and bore wells are getting deeper and deeper. Also due to increase in paved surface/roof areas, the amount of natural/percolation of rainfall is reducing very drastically. Therefore, it has become very necessary to harvest the rain water as maximum as possible. The drainage system needs to be planned with a view to incorporate rainwater harvesting principles.

3.6.2 Systems of Rainwater Harvesting

- Out of the various techniques adopted in India, and approved of by the Central Ground Water Authority, the following are the three main classes of rainwater harvesting systems:
  - System that collect direct roof runoff for storage and then reusing for various purposes.
• Systems that use in-field or adjoining surface catchments to collect run-off and then impounded for irrigation, horticultural, recreational & domestic purposes, after treatment.
• Systems that utilize the rainwater run-off from various surfaces including Terrace and Roads and green areas etc. for re-charging of the underground aquifer, through various measures.
• In this system, the catchments from roof/terrace areas are further segregated for direct recharging of aquifer through filter media.
• The catchment from surfaces of road/paved/park/lawns etc. is segregated and then taken to underground, through desalting chamber/oil and grease separator etc.
• Therefore as per prevailing practice and from a practical point of view in North India, it is more feasible and recommended to use rainwater to recharge groundwater aquifers than for direct storage. Therefore, it is proposed to implement the system as explained in Point ‘C’ above, so as to maximize the rain water utilization efficiency for recharging the underground aquifer.
• The entire rainfall is received over a period of 27 days, 80% of which falls in the period between July to September. The rainwater therefore has to be harvested during this short period.

3.6.3 References
• Manual on "Rain Water Harvesting & Conservation" by Govt. of India, Central Public Works Department (CPWD), New Delhi, June 2002.
• Guidelines from Central Water Board - Ministry of Water Resources, Govt. of India.
• A Water Harvesting manual for Urban Areas Case Studies from Delhi by Centre for Science & Environment.

3.6.4 Proposed Storm Water Drainage System
In general the rain water from terraces and other open areas shall be collected through Rain water down take pipes and connected to catch basins. The Rain water from hard courts and landscaped area shall be collected by catch basins through a RCC pipe network / or open drains with gratings and connected to the rain water harvesting pits in the premises and finally over flow from rain water harvesting will be led out to main Municipal Drainage.

3.7 Internal Plumbing System

3.7.1 Details of System

<table>
<thead>
<tr>
<th></th>
<th>System Designed</th>
<th>Two pipe (stack) system as recommended in code of practice for soil and waste pipes above ground (IS : 5329 – 1964)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Minimum Dia Adopted</td>
<td>(a) All main soil &amp; waste pipes and branches SCI pipe with hubless 110mm OD/90mm OD</td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td>---</td>
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<td></td>
</tr>
<tr>
<td>(b)</td>
<td>All Main soil &amp; waste vertical stacks 110 and 160mm OD as per requirement For kitchens dedicated stack to be provided.</td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>Vents Pipe If Required 110 mm OD</td>
<td></td>
</tr>
<tr>
<td>(d)</td>
<td>Wash Basin and kitchen waste connection to floor traps 40mm OD for Wash basine and 50mm for kitchen/pantry</td>
<td></td>
</tr>
<tr>
<td>(e)</td>
<td>Floor Drain 90 mm OD</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Vertical Pipe (Exposed &amp; approachable) All soil, waste, and vent pipes shall be running vertically in vertical shafts as per plumbing drawing.</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Access door junctions for cleaning purpose Each connection from the fixtures.</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Clean out Plugs Where two or three fixtures are connected to a single horizontal pipe leading to a vertical stack (in toilets), provided at starting point. The cleanout plugs shall have access from the ceiling or shall be flush with the finished floor level.</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Water seal for all traps Minimum 50mm</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Methodology of conveying horizontal soil &amp; waste pipes / sinking of slab (Option – I) At ceiling level below, by hanging the pipes with M.S structural supports/dash fasteners and proper clamping etc. with proper slope (1:60). All structural Beams at ceiling level should be inverted. App. 100mm sunken area required for connection of Wash Basin &amp; Floor Drain etc.</td>
<td></td>
</tr>
<tr>
<td>Option - II</td>
<td>At floor level below, by lying the pipes on floor with proper slope (1:60). All structural Beams at floor level should be downwards preferably. App. 350 mm sunken area required for connection of W.C., Wash Basin &amp; Floor Drain, traps etc. However incase of Indian W.C. the sunken area required is 450 mm.</td>
<td></td>
</tr>
<tr>
<td>Rain water pipe</td>
<td>UPVC pipe conforming to IS : 13592 Type A</td>
<td></td>
</tr>
</tbody>
</table>

3.7.2 Fixtures and Fittings
Sanitary fixtures shall be off-white vitreous china or as approved and of standard quality and make, as per requirement.

C.P. fittings shall be as per requirement and of good quality (as mentioned in BOQ).

While selecting and installing vitreous china and C.P. fittings, following attention has been given:

(A) **W.C.**

- Some toilets shall have Wall hung European type W.C. with flushing cistern as per requirement.
- In many cases like general toilets, utility room toilets, servant Toilets and etc. Indian W.C. with flushing cistern will be provided as per requirement.
- Toilet paper holder and ablution tap/Health faucet for E.W.C, while only ablution tap for I.W.C. will be provided.

(B) **Wash Basins**

- Circular tabletop/under counter and flat back wash basins with mirror, hot & cold water mixers as per requirement, liquid soap containers and towel rings.

(C) **Sinks**

- Stainless steel sinks/vitreous china sinks with drain-board with mixtures in kitchen, utility and pantries etc., as per requirements.

(D) **Urinals**

- Battery based infrared sensor operated urinals of size shall be provided in main toilets of the building.

### 3.8 IS Code for Plumbing Work

- **IS 651-1965** Specification for salt Glazed stoneware pipes and fittings (First revision).
- **IS 782-1978** Specification for caulking lead.
- **IS 1172-1971** Code of basic requirements for water supply, drainage and sanitation (revised).
- **IS 1239-1968 (Part-I)** Specifications for mild steel tube, tubular and other steel pipe fittings.
- **IS 1239-1968 (Part-II)** Specifications for mild steel tube, tubular and other steel pipe fittings.
- **IS 1537-1976** Specification for vertically cast iron pressure pipes for water, gas and sewage.
<table>
<thead>
<tr>
<th>IS No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 1536-1976</td>
<td>Specification for centrifugally Cast (Spun) Iron pressure pipes for water, gas and sewage.</td>
</tr>
<tr>
<td>IS 1538 (Part 1 to 23)</td>
<td>Specification for Cast Iron fittings for pressure pipes for water, gas and sewage.</td>
</tr>
<tr>
<td>IS 1626-1960</td>
<td>AC building pipes, gutters and fittings (Spigot and socket type).</td>
</tr>
<tr>
<td>IS 1726-1960</td>
<td>Code for cast iron manhole frame and cover.</td>
</tr>
<tr>
<td>IS 1729-1979</td>
<td>Specification for Sand cast iron Spigot and Ventilating pipes, fittings and accessories.</td>
</tr>
<tr>
<td>IS 2065-1963</td>
<td>Code of practice for water supply to buildings.</td>
</tr>
<tr>
<td>IS 3989-1970</td>
<td>Centrifugally cast spun iron and socket soil and ventilating pipe, fittings and accessories.</td>
</tr>
<tr>
<td>IS 4515</td>
<td>Specification for unplasticized PVC pipe fittings.</td>
</tr>
<tr>
<td>IS 1703-1984</td>
<td>Ball Valves</td>
</tr>
<tr>
<td>IS 2548-1970</td>
<td>Toilet Seat Cover</td>
</tr>
<tr>
<td>IS 4736-1986</td>
<td>Galvanizing G.I. Pipes</td>
</tr>
<tr>
<td>IS 780-1984</td>
<td>Cast iron sluice valves</td>
</tr>
<tr>
<td>IS 778-1984</td>
<td>Full way valves</td>
</tr>
<tr>
<td>IS 2692-1978</td>
<td>Brass ferrule</td>
</tr>
<tr>
<td>IS 458-1971</td>
<td>R.C.C. pipes</td>
</tr>
</tbody>
</table>

National building code 2016 for water supply, drainage and sanitation Part IX Plumbing
services section 1 & 2.

The installation shall also be in conformity with the bye-laws and a requirement of the local authority is so far as these become applicable to the installation. Where ever this specification calls for a higher standard of materials and/or workmanship then those required by any of the above regulations and standards, hen this specification shall take precedence over the said regulations and standards. Wherever drawings and specifications require something that may violate the regulations, the regulation shall govern.

3.9 Fire Fighting System

Introduction

- Type of the Buildings : Office, etc.
- Max height of Building : Category: Upto 10m height
- Categories as per NBC : Business building.

Note: Norms may be finalized as per final Architectural building section height.

References & Design Guideline Sources

- IS: 3844-1989 - Code of practice for installation and maintenance of internal fire hydrants and hose reels on premises.

Wet Riser & Hydrants System

The fire fighting system shall be provided mainly as per latest National Building Code of India (2016) (Part IV) and other relevant I.S. codes and it shall be consisting of:

As per NBC Downcomer system with landing hydrant valves and fire hose cabinet @ 900m² area minimum requirement for this building, Location to be as per final architectural layouts. (As per recommendations of IS:3844:1989, Code of practice for installation of Internal Hydrants)

Each Fire Hose Cabinet shall be consisting of:

- Nos., 63mm dia and 15m long rubberized fabric lined hose pipe as per IS: 636 type-II.
- Gunmetal/SS male and female instantaneous type coupling as per I.S:903 with I.S. specifications.
- Gunmetal/SS branch pipe with nozzle as per 1S:903
- First-aid fire hose reels with 20mm dia 30.0m long with 5mm bore gunmetal nozzle as per I.S:884 - 1969.
- Fireman’s axe.

Fire Pumps
- Downcomer system, shall be connected with the following type of fire pumps, which will be operated automatically and also on emergency supply.
  - One no. terrace Pump of 450 lpm discharge and 70m head.
- All fire pumps shall be with positive suction arrangements.

- All the fire pumps shall cut-in automatically based on the pressure settings, so as to ensure that the entire fire main line, risers etc. are pressurized on a continuous basis.

**Fire Extinguishers**

The following type of portable fire extinguishers shall be provided at all levels of the towers, at strategic locations as per requirements, generally to follow IS–2190:1992)

- Dry powder type of 6kg, capacity for every 100 m² of area -- IS : 15683
- One nos. 4.5 kg CO₂ type for every 100 m² of area -- IS : 15683
- Clean agent fire extinguisher (if required) for server rooms

### 3.10 IS Code for Fire Fighting Work

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 1239-1968 (Part-I)</td>
<td>Specifications for mild steel tube, tubular and other steel pipe fittings.</td>
</tr>
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</tr>
<tr>
<td>IS 4736-1986</td>
<td>Galvanizing G.I. Pipes</td>
</tr>
<tr>
<td>IS 636-1988</td>
<td>Non percolating flexible fire fighting delivery hose (third revision)</td>
</tr>
<tr>
<td>IS 694-1990</td>
<td>PVC insulated cables for working voltages up to and including 1.100 volts (third revision)</td>
</tr>
<tr>
<td>IS 778-1984</td>
<td>Copper alloy gate, globe and check valves for water works purposes (fourth revision) (Amendment 2)</td>
</tr>
<tr>
<td>IS 780-1984</td>
<td>Sluice valves for water works purposes (50 to 300 mm) size (sixth revision) (amendment 3)</td>
</tr>
<tr>
<td>IS 884-1985</td>
<td>Specification for first-aid hose-reel for firefighting (for fixed installations) (first revision) (with amendment No.1)</td>
</tr>
<tr>
<td>IS 900-1992</td>
<td>Code of practice for installation and maintenance of induction motors (second revision)</td>
</tr>
<tr>
<td>-------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>IS 901-1988</td>
<td>Specification for couplings, double male and double female, instantaneous pattern for firefighting (third revision)</td>
</tr>
<tr>
<td>IS 902-1992</td>
<td>Suction hose coupling for firefighting of purposes (third revision)</td>
</tr>
<tr>
<td>IS 903-1984</td>
<td>Specification of fire hose delivery couplings branch pipe, nozzles and nozzle spanner (third revision) (Amendment 5)</td>
</tr>
<tr>
<td>IS 937-1981</td>
<td>Specification for washers for water fittings for firefighting purposes (revised) (with amendment No. 1)</td>
</tr>
<tr>
<td>IS 1520-1980</td>
<td>Horizontal centrifugal pumps for clear cold, fresh water (second revision)</td>
</tr>
<tr>
<td>IS 1536-1976</td>
<td>Horizontally cast iron pressure pipes for water, gas &amp; sewage (first revision) (with Amendments No. 1 to 4)</td>
</tr>
<tr>
<td>IS 1554-1988 Part I</td>
<td>PVC insulated (heavy duty) electric cables (working voltage up to and including 1100 volts (third revision)</td>
</tr>
<tr>
<td>IS 1554-1988 Part II</td>
<td>PVC insulated (heavy duty) electric cables (working voltage from 3.3 KV up to and including 11 KV (second revision)</td>
</tr>
<tr>
<td>IS 1648-1961</td>
<td>Code of practice for fire safety of buildings (General) Firefighting equipment and its maintenance (with amendment No.1)</td>
</tr>
<tr>
<td>IS 3624-1987</td>
<td>Pressure and vacuum gauges (Second revision)</td>
</tr>
<tr>
<td>IS 4736-1968</td>
<td>Hot-dip zinc coatings on steel tubes (with Amendment No.1)</td>
</tr>
<tr>
<td>IS 5290-1983</td>
<td>Specification for landing valves (second revision)</td>
</tr>
<tr>
<td>IS 5312-1984 Part I</td>
<td>Swing check type reflux (non return) valves Part I-single door pattern (with amendments nos. 1 &amp; 2)</td>
</tr>
<tr>
<td>IS 5312-1986 Part II</td>
<td>Swing check type reflux (non return) valves Part II-Multi door pattern (with amendments nos. 1 &amp; 2)</td>
</tr>
<tr>
<td>IS 7285</td>
<td>Seamless cylinders for storage of gas at high pressure.</td>
</tr>
<tr>
<td>IS 2189-1962</td>
<td>Code of practice for Automatic Fire alarm system</td>
</tr>
<tr>
<td>IS 2195-1962</td>
<td>Specification for heat sensitive fire detectors</td>
</tr>
<tr>
<td>IS 732-1973</td>
<td>Code of practice for electrical wiring installation</td>
</tr>
</tbody>
</table>

**NOTE:** All capacity given in above is only for guidelines.

### 4.0 PLUMBING & FIRE FIGHTING TECHNICAL SPECIFICATION OF EQUIPMENTS

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4.1 Sanitary Fixture & Fitting

4.1.1 Scope of Work
Work under this section shall consist of furnishing all labor as necessary and required to completely install all Sanitary Fixtures, Brass and Chromium plated fittings and accessories as required by the drawings and specified hereinafter.

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.

Whether specifically mentioned or not all Fixtures and appliances shall be provided with all fixing devices, nuts, bolts, screws, hangers as required.

Testing of all fixture and fittings as per Indian Standard.

4.1.2 European Water Closest

General

The item pertains for providing and fixing white or colour glazed vitreous chinaware European or Anglo Indian water closet with seat and cover of size and colour as specified in the schedule including fixing.

Material

European type water closet shall be washing down pattern unless otherwise specified. Water closet shall be vitreous china conforming to IS 2556 (Part-I & II). The closet shall be of one piece construction and shall have minimum two hole of 6.5 mm diameter for fixing closet to floor. Closet shall have an integral flushing rim of self draining type. Each water closet shall have an integral.

Trap with either 'S' or 'P' outlet with and trap shall be uniform and smooth in order to enable an efficient flush. Plastic seat and cover shall be of black colour or as specified, they shall have conformity to IS2548 Part I & II.

Fixing

The water closet pan shall be placed in position as shown in the drawing. If the pan trap is damaged during handling or fixing, it shall be replaced by the contractor at his own cost. The pan, soil pipe shall be jointed in 1:1 Cement Mortar with hemp yarn caulked. The gap between W.C. and floor shall be finished with white/matching cement and sand as directed. Seat and cover shall be fixed to the Pan by two corrosion resistance hinge with 65 mm shank and threaded to within 25 mm from of flange. Seat shall be fixed in level by providing the washers of rubber with non ferrous or stainless steel washer to bolt.

4.1.3 Indian Water Closest

General

The item pertains for providing white or colour glazed vitreous chinaware Indian 84 water closet of size and colour as specified in the schedule including fixing.
Material

Squatting Pan (Orissa Pattern) is of white or colour glazed vitreous China conforming IS 2556 Part III. Pan shall have flushing rim and are inlet of self draining type. It shall have weep hole at the following inlet to the Pan. The flushing inlet shall be in front unless otherwise specified. The inside of the bottom of the pan shall have sufficient slope from the front to the outlet and surface shall be uniform and smooth to enable easy and quick disposal while flushing. The exterior surface of the outlet below the flange shall be an unglazed surface which shall have groove at right angle to the axis of the outlet. In all the cases pan shall have be provided with 100 mm Glazed Vitreous China ‘P’ or ‘S’ trap with 50 mm water seal and 40 mm size vent harm

Fixing

The water closet pan shall be placed in position as shown in the drawing. The IWC shall be supported on brick masonry in CM 1:4 or as directed by the Engineer-in-charge. The pan shall be fixed slightly lower than the floor level. If the pan or trap is damaged during handling of fixing, it shall be replaced by the contractor at his own cost. The pan, trap and C.I. pipe shall be jointed in 1:1 Cement Mortar with hemp yarn caulked. The gap between W.C. and floor shall be finished with white/matching cement as directed.

4.1.4 Wash Basin

General

The item pertains for providing colour or white glazed vitreous chinaware wash basin with or without pedestal of size and colour as specified in the schedule including fixing.

Material

Wash basins shall be of vitreous china conforming to IS : 2556(Part-IV) of flat back or angle back as specified shall be of one piece construction including combined over flow, basin shall be provided with single or double tap holes of size 28 mm square or 30 mm rounded. Each basin shall have circular waste hole, or 5 sq.cm slot type over flow. Pedestals for wash basin shall be exactly same glazing that of basin. Pedestal shall be capable of supporting the basin and completely recessed at the back to accommodate supply and waste pipes and fittings. The basin shall be supported on pan of C.I Cantilever brackets conforming to IS 775. Use of MS angle or Tee Section as bracket is not permitted.

Fixing

The wash basin shall be fixed in position as indicated in the drawing. Basin shall be supported on a pair of C.I brackets which is embedded in cement concrete (1:2:4) block 100 x 75 x 150 mm. Oval shape or round shape wash basins are required to be fixed in RCC platform with stone tapping either fully sunk in stone top or flush with stone topping. The wall plaster on seat shall be cut to rest over the top edge of the basin so as not to leave any gap for water seepage through between wall plaster & skirting of basin. The gap between basin and wall shall be finished with white matching cement.

4.1.5 Urinal
General

The item pertains for providing colour or white glazed vitreous chinaware urinal in single or range (1, 2 & 3) and size as specified in the schedule with necessary fittings and appliances including fixing.

Material

Bowl Type with Flushing Rim: Urinal basin shall be flat back or corner wall type lipped in front. The vitreous china conforming to IS 2556 (Part VI). Urinal shall have and integral flushing rim and inlet or supply horn for connecting flush pipe. Flushing rim and inlet shall be of the self draining type. at bottom of basin and outlet horn for connecting outlet shall be provided. The inside surface of the urinal shall be uniform and smooth throughout to ensure efficient flushing.

Bowl Type Flat Back without Flushing Rim: They shall be of vitreous china Conforming to IS: 2556 (Part-VI) constructed in one piece with providing slot or alternative fixing Arrangement at flat back and where the integral flushing rim is not provided, they shall be provided with ridges inside the bowl to divert towards the front line of the urinal.

Stall Urinals: The stall urinal and its screen shall be glazed fire clay conforming IS: 771(Part-III, Sec-2). The inside surface of stall and screen shall be regular and smooth throughout to ensure efficient flushing.

CP Brass Flush Pipe: The flushing arrangement to urinals for single or in range shall be of CP brass with CP brass spreader of 15 mm dia conforming to IS: 407. The capacity of flush pipe for urinal in a range shall be as follows:

<table>
<thead>
<tr>
<th>Nos. of urinals in range</th>
<th>Capacity of flush tank</th>
<th>Size of C.P. brass Flush pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Main</td>
</tr>
<tr>
<td>One</td>
<td>5 litres</td>
<td>15mm</td>
</tr>
<tr>
<td>Two</td>
<td>10 litres</td>
<td>20 mm</td>
</tr>
<tr>
<td>Three</td>
<td>10 litres</td>
<td>25 mm</td>
</tr>
</tbody>
</table>

Fixing

Bowl Type Flat Back without Flushing Rim: Urinal shall be fixed in position by using rawl plug, wooden plug, C.P screws etc. It shall be fixed at height of 65 cm from the standing level to the top of the lip of urinal or as directed by the Engineer-in-charge. Each urinal shall be connected with 32 mm size waste pipe which shall discharge into channel or a floor trap.

Stall Urinals: The stall urinal shall be flush with the finished floor level. The stall urinal shall be laid over a fine sand cushion on average 25 mm thickness. The gap between wall surface, finished floor level and urinals shall not be more than 3mm and filled with water proofing plastic compound.

CP Brass Flush Pipe: The flushing arrangement to urinal in single or range shall be of CP brass from 25 mm dia to 15 mm dia and CP brass spreader of 15 mm size to each urinal including the cost of CP brass elbows, tees, coupling, crosses, clamps, clips, union CP brass check nut and screws etc. CP brass
G.I. 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.

4.1.6 Flushing Cistern

General

The item pertains to provide white or colour glazed chinaware / PVC / Cast Iron flushing cistern with all inside syphonic fitting including fixing.

Material

The flushing cistern shall be automatic or manually of rates high level or low level as specified for water closets and urinals. Cisterns shall be of cast iron, vitreous china, enamelled pressed steel conforming to IS 774 for Flushing Type and IS 2326 for Automatic flushing cistern and Plastic (IS 7231). Cistern shall be mosquito proof. All working parts shall be designed to operate smoothly and efficiently. The cistern shall have removable covers which shall fit closely on it and be screwed against top displacement where operating mechanism is attached to the cover. This may be made in two section, but the section supporting the mechanism shall be securely fitted or screwed to the body. The outlet fitting of the cistern shall be securely connected to the cistern. The nominal internal diameter of the cistern outlet shall not be less than 32 mm and 38 mm for high level and low level respectively. Length of outlet cistern shall be 37 +/- 2 mm. Ball valve shall be screwed type 15 mm in diameter and shall confirm of IS 1703. The flat shall be made of polyethylene as specified in IS:9762. A high level cistern is intended to operate with minimum height of 125 cm and a low level cistern with maximum height of 30 cm between the top of the pan and under side of the cistern. A G.I chain strong enough to sustain a sudden applied pull of 10 kg or a dead load of 50 kg without any apparent or permanent deformation of the chain rings shall be attached to the ring or hook of the level manually operated high level C.I cistern. In case of low level cistern handle shall be of CP brass. In case of Plastic cistern, operation of cistern shall be through Push Button at the top for dual system and beyond plastic handle. The discharge rate of the cistern as per IS 774 shall be 10 +/- .5 liters 6 second and 5 +/- .5 liters in 3 second for cistern capacity 10 ltrs and 5 ltrs respectively. Flush pipe shall be of class ‘B’ G.I pipe of 32 +/- mm diameter for high level. Polyethylene flush pipe shall be low density confirming to IS 3076 or high density confirming to IS 4984 or UPVC pipe confirming to IS:4965 of 40 mm outer diameter. Over flow pipe shall not be less than +/- 5mm ‘B’ diameter. It shall be of G.I valve with mosquito proof jalli of 1.25 mm dia.

Fixing

The chinaware flushing cistern shall be placed over a pair of C.I. brackets. C.P. brass flush pipe shall be fixed to cistern and W.C. pan using check nut, spun yarn, cement mortar etc. The cast iron flushing cistern shall be placed over a pair of C.I. or G.I. or PVC flush pipe of specified diameter shall be fixed to cistern and W.C. pan by using check nut, white zinc, spun yarn, cement mortar etc. The PVC flushing cistern shall be placed or fixed as recommended by the manufacturer, PVC flush pipe of specified diameter shall be fixed to cistern and W.C. pan by using check nut, white zinc, spun yarn, cement

4.1.7 Stainless Seel Sinks

General
Item includes providing the stainless steel sink with or without drain board of size as specified in the schedule including fixing.

**Material**

The sink shall be manufactured from stainless steel of Salem or equivalent steel conforming to IS: 13983. Stainless steel sink shall be of one piece construction moulded out of 19 SWG (1mm) stainless steel sheet of grade AISI 304 (18/8) with stainless steel choke – stop strainer (waste coupling) check nuts conforming to IS 13983.

**Fixing**

The sink shall be fixed in position as indicated in the drawing. The sink shall be placed over the brackets or on the platform. Gap between sink and platform / wall shall be finished.

4.1.8 Half Round Channel

**General**

The item pertains for providing colour or white glazed vitreous chinaware half round channel of size and colour as specified in the schedule including laying and fixing.

**Material**

The half round channel shall be of white or colour glazed vitreous chinaware of size as mentioned in the schedule with or without dead end and shall conform to IS 2556 part VII.

**Fixing**

The channel shall be laid to the correct alignment to required slope. It shall be fixed on 80 mm thick bed of 1:2:4 cement concrete. The channel shall be used in standard length. Pieces are not allow except where it is necessary to make up exact length.

4.1.9 Glass Mirror

**General**

The item providing beveled or plain edges mirror with or without frame of size as mentioned in the schedule including fixing.

**Material**

The mirror shall be of superior sheet glass with edges rounded off or beveled, size 600 x 450 mm unless specified in the schedule. It shall be free from flaws, specks or bubbles and thickness plated and should not be less than 5.0 mm. The back of mirror shall be uniformly silver plated and should be free from silvering defects. Silvering shall now have a protective uniform covering of red lid paint, where beveled edge mirror are not available. Fancy looking mirrors with PVC beading:border or aluminum beading on stainless steel beading/border based on manufacturer's specification, provided nothing extra shall be paid on this account. The backing of mirror shall be provided with 6mm
thick marine plywood or environmentally friendly material other than asbestos cement sheet.

**Fixing**

Mirror shall be fixed in position with 6mm thick marine plywood backing. It shall be fixed by means of 4 nos. of CP brass screws & caps over rubber washers and rawl plug or as per the manufacturer's specification unless specified otherwise the longer side shall be fixed horizontally.

### 4.1.10 Shower Rose & CP Fittings

**General**

The item pertains to provide chromium plated brass shower rose of specified diameter with accessories including fixing.

**Material**

The shower rose & CP fittings shall be CP brass of approved and heavy quality. It's accessories shall conform to IS 1239 Part II.

**Fixing**

Shower rose & CP Fittings shall be fixed to be water supply pipe line with necessary G.I fittings etc. as required by the Engineer-in-charge. Jointing shall be done with the zinc, spun yarn etc. A few turns of fine hemp yarn dipped in linseed oil shall be taken over the threaded ends to obtain complete water tightness. Leaky joint shall be remade to make it leak proof at his risk & cost.

### 4.1.11 Accessories

Accessories shall be of any of the following types:

- **Towel rails**
  
  Towel rail shall be C.P brass of size 610mm long and 20mm dia, and fixing with C.P brass brackets fixed to wooden cleats with C.P brass screws.

- **Towel rings**
  
  Towel rail shall be C.P brass of size 150mm dia, and fixing with C.P brass brackets fixed to wooden cleats with C.P brass screws.

- **Toilet paper holder**
  
  Toilet paper holder shall be of Satin finish stainless steel AISI 316 grade wall mounted type fixed to wooden cleats with C.P brass screws.

- **Coat hooks**
  
  Coat hooks shall be of satin finish stainless steel AISI 316 grade wall mounted coat hooks fixed to wooden cleats with C.P brass screws or as directed by Engineer-in-Charge.
**Soap dispensers**

Soap dispensers shall be of satin finish stainless steel AISI 316 grade wall mounted liquid soap dispenser with indicator having bottom trough of soap fixed to wooden cleats with C.P. brass screws or as directed by Engineer-in-Charge.

Accessories shall be fixed with stainless steel half round head screws and cup washers in wall with rawl plugs or nylon sleeves and shall include cutting and making good.

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. The flange of the recessed fixture shall cover the recess in the wall fully.

Contractor shall install all Chromium Plated and porcelain accessories as shown on the drawings or directed by Engineer-in-Charge.

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.

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.

4.1.12 Urinal Partitions

Urinal partitions shall be white glazed vitreous china or 25mm/40 mm thick marble of size of 690x325mm.

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.

4.1.13 Toilet for the Disabled

Where specified, in washroom facilities designed to accommodate physically disabled, accessories shall be provided as per the NBC Norms for Disable Persons architectural drawing or as directed by the Engineer-in-Charge.

Stainless steel grab bars of 600mm long suitable for expose mounting and penned non-slip gripping surface shall be provided in washroom for disabled persons. The flushing cistern shall be provided with chromium plated long handles.

4.1.14 Testing and Acceptance

Testing is done as per BS-5572.

4.2 Internal Drainage Soil, Waste & Vent Pipes

4.2.1 Scope of Work

Work under this section shall consist of furnishing all labor, materials, equipments and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes as required by the drawings, specified hereinafter and as directed by the Engineer-in-Charge.
Without restricting to the generally of the foregoing, the soil, waste, vent and rainwater pipes system shall include the followings:-

- Vertical and horizontal Soil, Waste and Vent Pipes, Rainwater Pipes and Fittings, Joints Clamps and connections to Fixtures.
- Connection of pipes to Gully Traps & Manholes etc.
- Floor and urinal traps, cleanout plugs, inlet fittings and rainwater heads as specified.
- Waste pipes connections from all Fixtures e.g. wash basins, sinks, urinals and kitchen equipments.
- Testing of all pipes
- All works related to external sewerage network including connection municipal Manhole.

4.2.2 General Requirements
All materials shall be new of the best quality conforming to specifications and subject to the approval of Engineer-in-Charge.

Soil, waste and vent pipes in shafts, ducts and in concealed areas i.e. (false ceiling) shall consist of uPVC, SWR Pipe.

Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

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.

Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified. Pipes shall as far as possible be kept 50mm clear of wall.

Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.

Every waste pipes shall discharge above the grating of properly trapped gully. Contractor will ensure that this requirement is adequately met with. Wherever floor traps are provided it shall be ensured that at-least one washbasin/washing trough is connected to such floor traps to avoid drying of water seal in the trap.

All traps on branch soil and waste pipes shall also be ventilated at a point not less than 75mm or more than 300mm from their highest part and on the side nearest to the soil pipe or waste pipe.

All works shall be executed as directed by Engineer-in-Charge.

4.2.3 Soil, Waste & Vent Pipes
a) The Soil & Waste pipe system above ground has been planned as a "two pipe system" as defined in IS: 5329, having separate pipes for waste from kitchen sinks, showers, washbasins, and floor drains. Waste stacks have been provided with a "P" trap at ground floor.

b) All waste water pump rooms will be provided with a deep seal trap before connecting to the main drain or vertical stack.
c) Vertical soil & waste stacks shall be connected to an external manhole directly wherever feasible as shown on the drawings.
d) All soil and waste from areas below general ground level will be collected in sumps and pumped into drainage/sewer lines if any.
e) Anti-siphonage pipe (ASP) shall be provided for soil fittings on vertical stacks. It may also be provided for waste lines where shown on the drawings.
f) Vent pipes shall be provided at all sewer lines at the starting manholes.

4.2.4 Rainwater
a) All terraces shall be drained by providing down-takes rainwater pipes.
b) A separate piped drainage system for slopping roof with leaders shall be provided.
c) Rainwater pipes are separate and independent connected to the external storm water drainage system as shown on the drawings.
d) Rainwater in enclosed courtyards shall be collected in catch-basins and connected to storm water drains.
e) Any dry weather flow from waste appliances, AHU's pump rooms, shall be connected to the sewerage system only.

4.2.5 Balcony / Planter Drainage
Open balconies, terraces, planters and formal landscape areas will be drained by a separate pipe connected to external storm water drainage system.

4.2.6 SCI pipe for Soil & Waste
Soil, waste, vent and anti-siphonage pipes, fittings and accessories shall be SCI pipes with hubless connections. All pipes shall be straight and smooth and their inside free from irregular bore, blow holes, cracks and other manufacturing defects.

4.2.7 Fittings
Fittings shall conform to the same Indian Standard as for pipes. Contractor shall use pipes and fittings of matching specifications.

Fittings shall be of the required degree of curvature with or without access door as detailed in the drawings or as directed.

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 water tight.

4.2.8 Fixing
All vertical pipes shall be fixed by MS 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).

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.
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 by the Contractor at his own cost to restore the surfaces.

4.2.9 Clamps
Holder bat clamps shall be of standard design fabricated from MS flats 40x3mm thick and 12mm dia MS rod and 6mm nuts and bolts; painted with two coats of black bitumen paint before fixing. The clamps shall be fixed in cement concrete 1:2:4 mix (1 cement : 2 sand : 4 stone aggregate 20mm nominal size) blocks 100x100x100mm deep.

Where holder bat clamps are to be fixed in RCC column or slotted angles, walls or beam they shall be fixed with 40x3mm flat iron “U” type clamps with anchor fasteners of approved design.

Structural clamps shall be fabricated from MS structural members e.g. rods, angles, channels, flats as per detailed drawing or as directed. Contractor shall provide all nuts, bolts, welding material and paint the clamps with one coat of red oxide and two or more coats of black enamel paint to give an even shade.

Wherever MS clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement, RCC block and making good with cement concrete 1:2:4 mix (1 cement : 2 sand : 4 stone aggregate 20mm nominal size) as directed by the Architect/Consultants.

4.2.10 uPVC pipes for rain water system

Pipes
- All pipes shall be straight and smooth and inside free from cracks and other manufacturing defects. Pipes shall be conforming to I.S. 13952 type A for rain water.
- Pipes shall be joined by approved type of socket and ‘O’ rubber ring (confirms to IS:5382) joints with rubber lubricant.

Fittings
- Fittings shall conform to the Indian Standard recommended for the pipes. Pipes and fittings must be of matching I.S. Specification. Interchange of pipes of one standard with fittings on the other standard will not be permitted.
- Fittings shall be of the required degree of curvature with or without access door.
- Connection from a vertical stack or position to a horizontal line shall be made only by a “Y” junction.

Fixing
- All vertical pipes shall be fixed truly vertical to walls with approved type of uPVC saddle clamp. 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). However shaft where more vertical pipes run, the pipes may be fixed to the slotted angle/channel supports fixed to walls at intervals specified here under:-
- Horizontal pipes running along ceiling shall be fixed on galvanized structural adjustable clamps (Clevis 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.
- Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the Engineer-in-charge for making such provisions in the structure as necessary. All damages shall be made good to restore the surfaces at no extra cost.

**Clamps**

- Holder bat clamps shall be of standard design and fabricated from galvanized M.S. standard flats 40x3 mm thick and 12 mm dia M.S. Rod and 6 mm nuts and bolts. Holder bat clamps shall be fixed in cement concrete 1:2:4 mix blocks 10x10x10 cms deep.
- Where holder bat clamps are to be fixed in RCC column or slotted angles, walls or beam they shall be fixed with galvanized 40x3 mm flat iron "U" type clamps with anchor fasteners of approved design or 6 mm nuts and bolts.
- For SWR pipes conforming to IS 13592 shall be clamped to wall with approved type of uPVC saddle clamp/ U-clamp or as given in the Bill of quantities.
- Structural clamps shall be fabricated by electro-welding from M.S. structural members e.g. rods, angles, channels flats as per detailed drawing. Contractor shall provide all nuts & bolts, welding material. All fabricated clamps, nuts, bolts and washers shall be not dipped galvanized.
- Galvanized slotted angle/channel supports on walls shall be provided wherever shown on drawings. Angles/channels shall be of sizes shown on drawings or specified in schedule of quantities. Angles/channels shall be fixed to brick walls with bolts embedded in cement concrete blocks and to RCC walls with suitable anchor fasteners. The spacing of support bolts horizontally shall not exceed 1 m.
- Wherever M.S. clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement and making good with cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 mm stone aggregate 20 mm nominal size) as directed by the Engineer-in-Charge.
- Sleeves, anchor fasteners and clamp spacing chart for all type of pipes should be as per latest code of practice and NBC2016:

### 4.2.11 Traps

**Floor Traps**

Floor traps shall be siphon type full bore P or S type cast iron having a minimum 50 mm deep seal. The trap and main waste pipes in toilets having 150 mm sinking shall run below slab and shall be supported from the ceiling below. The trap and waste pipes in sunken area (where required) shall be set in cement concrete blocks firmly supported on the structural floor. The blocks shall be in 1 : 2 : 4 mix (1 cement : 2 coarse sand : 4 stone aggregate 20 mm nominal size) and extended to 40 mm below finished floor level. Contractor shall provide all necessary shuttering and centering for the blocks. Size of the block shall be 30x30 cms of the required depth.

**Urinal Traps**
Urinal traps/horn shall be cast iron P or S traps with or without vent shall be fixed as specified for floor traps.

**Floor Trap Inlet**

Bath room traps and connections shall ensure free and silent flow of discharging water. Where specified, Contractor shall provide a special type inlet fitting fabricated from uPVC pipe without, with one, two or three inlet sockets fixed on side to connect the waste pipe. Joint between waste and hopper inlet socket of the trap shall be joined with solvent cement recommended by the manufacturer. Inlet shall be connected to a uPVC. P or S trap. Floor trap inlet hoppers and the traps if set in cement concrete blocks as specified in para above without extra charge. uPVC multi-inlet trap can be used where ever possible to be decided by the Engineer-in-Charge.

<table>
<thead>
<tr>
<th>Appliance or ware</th>
<th>Material</th>
<th>Trap Type</th>
<th>Seal Depth (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lavatory/wash basin</td>
<td>C.P. cast brass</td>
<td>32 mm dia Bottle</td>
<td>75 mm</td>
</tr>
<tr>
<td>Sink</td>
<td>C.P. cast brass</td>
<td>40 mm dia Bottle</td>
<td>75 mm</td>
</tr>
<tr>
<td>Kitchen floor drain of fabricated drain boxes</td>
<td>C.I.</td>
<td>75/100 mm dia ‘P’ or ‘S’</td>
<td>50 mm</td>
</tr>
<tr>
<td>Urinals</td>
<td>C.I.</td>
<td>100 mm dia ‘P’ or ‘S’</td>
<td>50 mm</td>
</tr>
</tbody>
</table>

**Trap & Seals**

All traps shall be self cleaning design and the seal depth shall be as specified below wherever the traps are not integral with the appliances:

**Floor Gratings**

Floor and urinal traps shall be provided with 100-150mm square or round C.P./ Stainless steel grating, with rim of approved design and shape. Minimum thickness shall be 4 mm.

**Jointing**

Pipe to pipe and pipe to fitting (SWR) joint shall be with ‘O’ rubber ring as recommended by the manufacturer. Jointing with solvent cement shall be applied to uPVC waste pipes (confirming to I.S. 4985) and fittings or as recommended by the manufacturer’s.

**4.2.12 Cleanout Plugs (On Soil Pipes)**

SCI Clean out pipe for Soil, Waste or Rainwater pipes laid under floors shall be provided near pipe junctions bends, tees, “Ys” and on straight runs at such intervals as required as per site conditions. Cleanout pipe shall terminate flush with the floor levels.
Cleanout on Drainage Pipes

Cleanout pipe shall be provided on starting point of each drain and in between at locations indicated on plans or directed by the Engineer-in-Charge. Cleanout pipe shall be of size matching the full bore of the pipe but not exceeding 150 mm OD.

Cleanouts at ceiling level pipe shall be provided with a bend terminating at floor level above. The cap of the cleanout pipe shall have a cap flush with floor.

4.2.13 Waste pipe from appliances

General

a) Waste pipe from appliances e.g. wash basins, sinks and urinals shall be of uPVC pipes 40, 50 or 63 mm OD conforming to IS:4985 class II (6 kg/cm²) shown on the drawings.

b) 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 galvanized structural clamps. Spacing for clamps for such pipes shall be as per the pipe spacing chart given in Section-1.

Encasing Pipe in Cement Concrete

Soil and waste pipes and drainage under floor 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 at intervals of one meter.

Testing

Testing procedure specified below apply to all soil, waste and vent pipes above ground including pipes laid along basement ceiling.

Entire drainage system shall be tested for water tightness during and after completion of the installation. No portion of the system shall remain untested. Contractor must have adequate number of expandable rubber/bellow plugs, manometers, smoke testing machines, pipe and fitting work test benches and any other equipment necessary and required to conduct the tests. All testing equipment/motors etc. shall be certified for its calibration by an approved laboratory.

All materials obtained and used on site must have manufacturer’s Hydraulic Test Certificate for each batch of materials used on the site.

Testing Soil, Waste and Rainwater Pipes

Apart from factory test all pipes and fittings shall be hydraulically tested for a head of 3 m preferably on a specially set up work bench. After applying pressure, strike the pipe with a wooden pallet and inspect for blow holes and cracks. Pressure may be applied for about 2 minutes. Reject and remove all defective pipes.
After installation all connections from fixtures, vertical stacks and horizontal drains including pipes along ceiling shall be tested to a hydraulic pressure not exceeding 3 m. Such tests shall be conducted for each floor separately by suitable plugs.

After the installation is fully complete, it should be tested by flushing the toilets, running at least 20% of all taps simultaneously and ensuring that the entire system is self draining, has no leakages, blockages etc. Rectify and replace where required.

Contractor shall maintain a test register identifying date and time of each area. All tests shall be conducted in presence of Engineer-in-Charge and signed by both.

4.3 Excavation for Pipe Line

4.3.1 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.

4.3.2 Opening out Trenches

In excavation the trenches, etc. the solid road metal ling, 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.

4.3.3 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.

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.
4.3.4 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.

4.3.5 Refilling
After the pipes or other work has been laid and proved to be water tight, the trench or other excavations 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.

4.3.6 Contractor to Restore Settlement and Damages
The Contractor shall, at his own costs and charges, make good promptly during the whole period the works are in hand, any settlement that may occur in the surfaces of roads, beams, footpaths, gardens, open spaces etc. Whether public or private 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 liberty to get the work done by the Contractor or deducted from any money that may be or become due to him or recovered from him in any other manner according to the law of the land.

4.3.7 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.

4.3.8 Timbering of Sewer and Trenches
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.

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.

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.

4.3.9 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.

4.3.10 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.

4.3.11 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.

4.4 Water Supply System (Cold & Hot)

4.4.1 Scope of Work

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.

Without restricting to the generality of the foregoing, the water supply system shall include the following:

a) Municipal water connection including water meter up to U.G. water tanks.
b) Piping from tube well to raw water tank
c) Over Head Tank filled by fixed speed transfer pumps and building OH tanks filling through by gravity from elevated OHT.
d) Distribution system from overhead tank to toilets and other wet area in the building by gravity to all floors.
e) Excavation and refilling of pipes trenches.
f) Control valves, masonry chambers and other appurtenances.

- All water lines to different parts of building and making connection from source etc.
- Pipe protection and painting.
- Providing Hot water supply and return lines and insulation of hot water pipe lines.
- Control valves, masonry chambers and other appurtenances.
- Connections to all toilets kitchen equipments, tanks and appliances.
- Excavation and refilling of pipe trenches, wherever necessary.
- Trenches for taking pipe lines for these services if required.

4.4.2 General Requirements

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.

Pipes and Fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

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.

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.

Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.

As far as possible, all piping inside the buildings shall run either concealed or embedded.

Outside the buildings the piping shall be installed at-least 60cms below finished grade. All galvanized steel piping embedded either in trenches or in concrete and masonry work shall be tightly wrapped 1mm thick fiberglass tissue laid in bitumen.

Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

Water Supply System

Contractor should study the site plan and water supply system diagram for an overview of the system.

Source

a) Water supply will be acquired from Municipal water mains through a service connection.

b) Additional water supply will be obtained from captive tube-wells within the site. The rising mains will be connected to the main fire static tank and then overflow into the main domestic water tank.

Water supply piping for garden hydrant and sprinkler and irrigation system will be separate and independently connected to a different pumping system.

4.4.3 G.I. Pipes & Fittings

All pipes outside the building and pipes running at site, Shaft & terrace level shall be galvanized steel tubes conforming to IS: 1239-1979 of class specified. When class is not specified they shall be medium class.
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 and Bushes. Fittings shall be of IS:1879-(Part-I to X) 1975.

Pipes and fittings shall be jointed with threaded fittings. Care shall be taken to remove burr from the end of the pipe after cutting by a round file. 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.

4.4.4 Clamps

G.I. pipes in shafts and other locations shall be supported by galvanized clamps of design approved by Engineer-in-Charge Pipe in wall chases shall be anchored by iron hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from galvanized structural as described in the sub section. Pipes in typical shafts shall be supported on Slotted Angles/Channels as specified elsewhere. Pipe hangers shall be provided at the following maximum spacing:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Pipe Dia (mm)</th>
<th>Hanger Rod Dia (mm)</th>
<th>Spacing between Supports (Mtr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Upto 25</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>32 to 50</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>65 to 100</td>
<td>12</td>
<td>2.4</td>
</tr>
<tr>
<td>4</td>
<td>125 to 150</td>
<td>16</td>
<td>3.6</td>
</tr>
<tr>
<td>5</td>
<td>200 to 300</td>
<td>19</td>
<td>5.3</td>
</tr>
</tbody>
</table>

4.4.5 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.

4.4.6 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. 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 Bolt hole dia for flanges shall conform to match the specification for C.I. Sluice Valve to I.S. 780.
4.4.7 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:

<table>
<thead>
<tr>
<th>Dia of Pipe</th>
<th>Width of Trench</th>
<th>Depth of Trench</th>
</tr>
</thead>
<tbody>
<tr>
<td>15mm to 50mm</td>
<td>30 cms</td>
<td>60 cms</td>
</tr>
<tr>
<td>65mm to 100mm</td>
<td>45 cms</td>
<td>75 cms</td>
</tr>
</tbody>
</table>

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 earth work 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.

4.4.8 Painting
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.

All pipes in chases and below floor shall be provided with Anti-corrosive treatment.

4.4.9 Pipe protection
Where specified in the Drawing all pipes below ground shall be protected against corrosion by wrapping 100mm wide and 4mm thick layer of PYPKOTE/MAKPOLYKOTE over the pipe.

4.4.10 Sand Filling
All G.I. pipes in trenches shall be protected with fine sand 150 mm all around before filling in the trenches.

4.4.11 Gunmetal Valves
Valves 65mm dia and below shall be heavy Gunmetal Full way Valves or Globe Valves or Ball valves conforming to IS:778-1971 of 20 Kg/cm2 class. Valves shall be tested at manufacturer’s works and the same stamped on it.

All Valves shall be approved by the Engineer-in-Charge before they are allowed to be used on work.

4.4.12 Sluice Valves
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.

Sluice valves shall be of best quality conforming to IS: 780-1969 of class specified.
• 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.
• Sluice valves shall be installed at all branches and as shown on the drawings.

4.4.13 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.

4.4.14 Air Release Valves
• Air release valves shall be single acting type air valves with Gunmetal body and
bronze/gunmetal internal parts and plastic float.
• Each air release valve shall be provided with a cast iron isolating sluice valve of
specification given above.

4.4.15 Insulation
For Chased Internal Pipes
Hot water pipes fixed in chase shall be thermal insulation over hot water pipes with 9mm
thick nitrile or approved equivalent thermal insulation tubing, a elastomeric flexible
material having hermetic blister closed cell structure of expanded synthetic rubber having
a thermal conductivity not exceeding 0.040 w/m°k @ 40deg C over pipes.

4.4.16 Anchor Block
Suitable anchor blocks shall be provided at all bends and tees to encounter the excessive
thrust developed due to water hammer.

4.4.17 Cpvc Pipes
All pipes inside the buildings and where specified, outside the building shall be CPVC
pipes tubes conforming to IS 15778:1996 .Specific Gravity ASTM D 792 at 230C should be
1.55 as specified. With Tensile Strength as per ASTM D 638 at 230C should be 55N/mm2.

Cutting
Pipes shall be cut either with a wheel type plastic pipe cutting or hacksaw blade and care
shall be taken to make a square cut which provides optimal bonding area within a joint.

Deburring / Beveling
Burrs and fittings should be removed from the outside and inside of pipe with a pocket
knife or file otherwise burrs and fittings may prevent proper contact between pipe and
fitting during assembly.

Fitting Preparation
A clean dry rag/cloth should be used to wipe dirt and moisture on the fitting sockets and
tubing end. The tubing should make contact with the socket wall 1/3 or 2/3 of the way
into the fitting socket.

Solvent Cement Application
Only CPVC solvent cement confirming to ASTM-F493 should be used for joining pipe with fittings. CPVC schedule 40 & 80 heavy bodied CPVC solvent cement only should be used confirming to ASTM-F493.

**Assembly**

After applying the solvent cement on both pipe and fitting socket, pipes should be inserting into the fitting socket within 30 seconds, and rotating the pipe ¼ to ½ turn while inserting so as to ensure even distribution of solvent cement with the joint. The assembled system should be held for 10 seconds (approx) in order to allow the joint to set up.

An even bead of cement should be evident around the joint and if this bead is not continuous, remake the joint to avoid potential leaks.

**Set & Cure times**

Solvent cement set & cure times shall be strictly adhered to as per the below mentioned table:

Minimum Core prior to pressure testing at 150 PSI

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Ambient Temperature during Core period</th>
<th>Pipe Size</th>
<th>½” to 1”</th>
<th>1.1/4” to 2”</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Above 15 deg C</td>
<td>1 Hr</td>
<td>2 Hrs</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>4 – 15 deg C</td>
<td>2 Hrs</td>
<td>4 Hrs</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Below 4 deg C</td>
<td>4 Hrs</td>
<td>8 Hrs</td>
<td></td>
</tr>
</tbody>
</table>

Once an installation is completed and cored as per above mentioned recommendations, the system should be hydrostatically pressure tested at 150 PSI (10 Bar) for minimum 24hrs. During pressure testing the system should be filled with water and if a leak is found, the joint should be cut out and replacing the same with new one by using coupler.

**Transition of CPVC to Metals**

When making a transition connection to metal threads, special brass/plastic transition fitting (Male & Female adopters) should be used. Plastic threaded connection should not be over torque hard tight plugs one half turn should be adequate.

**Threaded Sealants**

Teflon tapes shall be used to make threaded connection leak proof.

**Hangers & Supports**

For horizontal runs, support should be given at 3 ft (90 cms) intervals for diameter of 1” and below and at 4 ft (1.20 mtr) intervals for larger size.
Hangers should not have throw or sharp edges which come in contact with the tubing and shall be of GI.

Support should be as per the below mentioned table:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Size of Pipe Inch</th>
<th>210 C Ft</th>
<th>490 C Ft</th>
<th>710 C Ft</th>
<th>820 C Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>½&quot;</td>
<td>5.5</td>
<td>4.5</td>
<td>3.0</td>
<td>2.5</td>
</tr>
<tr>
<td>2</td>
<td>¾&quot;</td>
<td>5.5</td>
<td>5.0</td>
<td>3.0</td>
<td>2.5</td>
</tr>
<tr>
<td>3</td>
<td>1&quot;</td>
<td>6.0</td>
<td>5.5</td>
<td>3.5</td>
<td>3.0</td>
</tr>
<tr>
<td>4</td>
<td>1¼&quot;</td>
<td>6.5</td>
<td>6.0</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>5</td>
<td>1½&quot;</td>
<td>7.0</td>
<td>6.0</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>6</td>
<td>2&quot;</td>
<td>7.0</td>
<td>6.5</td>
<td>4.0</td>
<td>3.5</td>
</tr>
</tbody>
</table>

All special fittings and accessories like internally or externally threaded brass adaptors, ball valves, globe valves, unions, diaphragm valves, butterfly valves, etc shall be made of CPVC by licensee.

The CPVC solvent cement used for installing CPVC piping systems shall conform to ASTM F493. Pipes from ½" up to 2" pipes and fittings, single step medium bodied CPVC solvent cement should be used. For CPVC pipes and fittings upwards of 2", a primer shall be used followed by heavy bodied solvent cement conforming to ASTM F493. **PVC solvent cement should not be used.**

**Concealed Plumbing**

All internal concealed plumbing for water supply shall be done with CPVC pipes. The pipes & fittings shall conform to CTS (Copper Tube Size) SDR–11 as per ASTM D2846. All pipes and fittings from ½" up to 2" shall come under this category. Medium body CPVC solvent cement conforming to ASTM F493 should be used for joining pipes to fittings.

**Installation procedure**

All parameters pertaining to the installation of CPVC plumbing system such as cutting, joining, support spacing, expansion loops, insulation, type of support, special connections, etc. shall be as per the manufacturer’s specifications.

**4.4.18 Valve Chambers**

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) 12 mm thick cement plaster inside and outside finished with a floating coat of neat cement inside with cast iron surface box as approved or as specified in Drawing and in drawings including excavation, back filling complete.
4.4.19 Water Meters

Water meters of approved make and design shall be supplied for installation at locations as shown in drawing the water meters shall meet with the approval of the local municipal authorities. Suitable valves and chambers to house the meters shall also be provided along-with the meters.

All meters shall conform to Indian Standard IS: 779-1978 (Water meters-domestic type) and IS: 2373-1981 (water meters-bulk type). Where called for water meters shall be located in masonry chambers of appropriated size.

4.4.20 Pipe Hangers Brackets etc.

Sturdy hangers, brackets and saddles of approved design shall be installed to support all pipe lengths which are not embedded over their entire run. The hangers and brackets shall be of adjustable heights and primer coated with red-oxide primer clamps. Collars and saddles to hold pipes shall be provided with suitable gaskets. The brackets and hangers shall be of Mild Steel designed to carry the weight of pipes safely and without excessive deflections.

All pipes and fittings shall be supported near every joint and half-way through every pipe length unless otherwise specified. Where called for, pipe hangers shall also be supplied with proper sound and vibration dampening devices to minimize noise and vibration transmission.

4.4.21 Testing

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/cm² in any case and with the consent of Engineer-in-Charge.

Pressure shall be maintained for a period of at least TWELVE hours without appreciable drop in the pressure after fixing at site. (+10 %). A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and Engineer.

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.

After completion of the water supply system, Plumbing 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.

4.4.22 Connections to Water Tanks

The contractor shall provide all inlets, outlets, washouts, vents, ball cocks, overflow, control valves and all such other piping connections including level indicator to water storage tanks as called for.
Suitable float controls of an approved make, securely fixed to the tank independent of the inlet pipe and set in a position so that water inlet into the tank is cut off when filled up to the water line. The water level in the tanks shall be adjusted to 25mm below the lip of the overflow pipe. Full way gate/ball valves of approved make shall be provided as near the tank as practicable on every outlet pipe from the storage tank except the overflow pipe.

The overflow pipe shall be so placed as to allow the discharge of water being readily seen. The overflow pipe shall be of size indicated. A stop valve shall also be provided on the inlet water connection to the tank. The outlet pipes shall be fixed approximately 75mm above the bottom of the tank towards which the floor of the tank is sloping to enable the tank to be emptied for cleaning. The ball valves shall conform to Indian Standard IS:1703-1968.

4.4.23 Connections to Mechanical Equipment Supplied by Other Agencies
All inlets, outlets, valves, piping and other incidental work connected with installation of all mechanical equipment supplied by other agencies shall be carried out by the Plumbing contractor in accordance with the drawings, requirements for proper performance of equipment, manufacturer's instructions and the directions of the Engineer-in-Charge. The equipment to be supplied by other agencies consists mainly of Kitchen, Laundry, Air-conditioning, Water Treatment and other similar equipment. The connections to the various equipment shall be effected through proper unions and isolating valves. The work of effecting connections shall be executed in consultation with and according to the requirements of equipment suppliers, under the directions of the Engineer-in-Charge. The various aspects of connection work shall be executed in a manner similar to the work of respective trades mentioned elsewhere in these specifications.

4.4.24 Disinfection
After completion of the work Contractor shall flush clean the entire system with the city's filtered water after connection has been made.

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. The Commissioning would not be considered complete without performing the Disinfection.

4.4.25 Pre Commissioning
Ensure that all pipes are free from debris and obstructions.
Check all valves and fire hydrant for effective opening and closing action. Defects should be rectified or valves replaced.
Ensure that all Connections to Branches has been made.
Ensure that mains have been connected to the respective pumps, underground and overhead tanks.
Water supply should be available at main Underground tank.
All main line Valves should be closed.

4.4.26 Commissioning
Fill Underground tank with water. Add 1kg fresh bleaching powder after making a solution to be added near inlet.
Start Water Supply Pump and allow water to fill main Underground tank. Water will first fill the fire tank and then overflow to the Raw Water tanks.

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).

Fill Overhead tank to full.

Release water in the main lines by opening Valves in each circuit. Drain out water in the system through scour valves or fire hydrant in lower regions. Ensure clean water is now coming out of the system.

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.

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.

The entire water supply system should be disinfected with bleaching powder and system flush cleaned.

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).

4.4.27 Responsibility
Responsibility for various activities in pre-commissioning and commissioning procedures will rest with the Contractor.

4.5 Sewerage / Drainage System
4.5.1 Scope of Work
Work under this section shall consist of furnishing all Labor, Materials, Equipments and Appliances necessary and required to completely finish Sewerage/Drainage system as specified hereinafter or given in the Drawing.
Without restricting to the generality of the foregoing, the sewerage system shall include:

- Internal/External sewer line.
- Excavations including refilling etc.
- Construction of Collection Chambers, Manholes and Drop Connections.
- Construction of Grease Trap etc.
- Storm Water Drainage and Disposal.
- Construction of Desalting chamber & Rain water Harvesting tank
- Testing of pipe lines

4.5.2 General Requirements
All materials shall be new of the best quality conforming to specifications and subject to the approval of the Engineer-in-Charge.
Drainage lines shall be laid to the required gradients and profiles.
All piping shall be installed at depth greater than 80cms below finished ground level.
The piping system shall be vented suitably at the starting point of all branch drains, main drains, and the highest/lowest point of drain and at intervals as shown. All venting arrangement shall be un-obstructive and concealed. All drainage work shall be done in accordance with the local Municipal bye-laws. Wherever the sewerage pipes run above water supply lines, same shall be completely encased in cement concrete 1:2:4 all round with the prior approval of the Engineer-in-Charge. Location of all manholes, catch basins etc., shall be got confirmed by the Contractor from the Engineer-in-Charge before the actual execution of work at site. All works shall be executed as directed by Engineer-in-Charge.

4.5.3 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.

4.5.4 Salt Glazed Stoneware Pipes
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 IS:651-1971 and shall be of approved makes.

The maximum permissible slope to the various diameters of pipes shall be as follows:

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>1 in 40 to 1:50</td>
</tr>
<tr>
<td>150</td>
<td>1 in 60 to 1:100</td>
</tr>
<tr>
<td>200</td>
<td>1 in 80 1:120 to 1:200</td>
</tr>
<tr>
<td>250</td>
<td>1 in 90 1:120 to 1:250</td>
</tr>
</tbody>
</table>

Where necessary, pipe shall be laid on a bed of plain cement concrete 1:3:6 and minimum 150 mm thick, and shall be projected by providing hunching up to half the diameter of the pipes. The width of the concrete bed for various diameters shall be as follows:

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>Width (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>380</td>
</tr>
<tr>
<td>150</td>
<td>450</td>
</tr>
<tr>
<td>200</td>
<td>600</td>
</tr>
<tr>
<td>250</td>
<td>700</td>
</tr>
</tbody>
</table>

Where the pipes are laid on a soft soil, with the maximum water table level, lying at the invert level of the pipe, the pipe shall be bedded in concrete.

4.5.5 Laying of Pipes
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.

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 allow the joint to be made.

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.

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.

4.5.6 Jointing of Pipes

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.

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.

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.

- **Gully Traps**
  Gully traps shall be of the same quality as described for stoneware pipes in Clause 5. 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.

- **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 constructed to size as shown at the location on drawings. The grease trap shall be provided with drop inlet, drop outlet, galvanized 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' as per the drawing.

- **Testing of Grease Trap**

All rights of the sewer and drain shall be carefully tested for water tightness by mains of water pressure maintained for not less than 30 minutes. Testing shall be carried out for manhole to manhole. All pipes shall be subject to a test pressure of 1.5 meter head of Water. The test pressure will however, not exceed 6mtr head at any point. The pipes shall be plugged preferably with standard design plugs or with rubber plugs on both sides, the upper end shall, however, be connected to a pipe for filling with water and getting the required head poured at one time.

**4.5.7 Reinforced Cement Concrete Pipes**

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.

**4.5.8 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 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 bonding rods etc. cradles or concrete bed may be omitted, if directed by the Engineer-in-Charge.

**4.5.9 Encasing (all pipes have to be encased)**

The sewer pipes shall be completely encased or surrounded with concrete where:

- The maximum water table level is likely to rise above the top of the barrel.
- The top (overt) of pipe is less than 200 cms under the road surface.

**4.5.10 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 semi flexible type collar joint.
4.5.11 Curing
The joint shall be cured for at least 7 days. Refilling at joints will be permitted only on satisfactory completion of curing period.

4.5.12 Cement Concrete and Masonry Works for Manholes and Chambers etc.

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 well enough for construction purpose.

Aggregate for Concrete
The aggregate for concrete shall be in accordance with IS: 383 and IS: 515 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. The size of the coarse aggregate shall be done as per IS: 383.

Sand
Sand for various constructional purposes shall comply in all respects with IS: 650 and IS: 2116. 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.

Cement
The cement used for all the constructional purposes shall be ordinary Portland cement or rapid hardening Portland cement conforming to IS: 269.

Mild Steel Reinforcement
The mild steel for the reinforcement bars shall be in the form of round bars conforming to all requirements of IS: 432 (Grade I).

Bricks
Bricks shall have uniform color, 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.

Other Materials
Other materials not fully specified in these specifications and which may be required in the work shall conform to the IS code. All such materials shall be approved by the Engineer-in-Charge before use.

4.5.13 Cement Concrete (Plain or Reinforced)
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.

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.

4.5.14 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 Drawing in cement mortar 1:5 mix (1 cement: 5 coarse sand). All joints shall be properly raked to receive plaster.

4.5.15 Cement Concrete for Pipe Support

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 Drawing. Type of the bedding is as described as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Upto 3 M depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipes in open ground (No sub soil water)</td>
<td>All round (1:4:8)</td>
</tr>
<tr>
<td>Pipes (all) in sub soil water condition</td>
<td>All round (1:4:8)</td>
</tr>
<tr>
<td>Pipes under the building or at road crossing or under public places</td>
<td>All round (1:3:6)</td>
</tr>
</tbody>
</table>

(1=1 cement, 3-5=coarse sand, 6-10 stone aggregate 40mm nominal size)

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.

Pipes in loose soil or above ground shall be supported on brick or RCC anchor blocks as shown on the drawings.

4.5.16 Manholes and Chambers

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 Drawing.

All Manholes, Chambers, etc., shall be supported on base of cement concrete of such thickness and mix or shown on the drawings.

Where not specified, Manholes will be constructed as follows:-
### All dimensions internal clear in cms

<table>
<thead>
<tr>
<th>Size of Manhole Type</th>
<th>91 dia Circular</th>
<th>122 dia Circular</th>
<th>152 dia Circular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum depth</td>
<td>167</td>
<td>229</td>
<td>Any depth beyond 229</td>
</tr>
<tr>
<td>Average thickness of R.C.C slab</td>
<td>---</td>
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<td>---</td>
</tr>
<tr>
<td>Size of cover and frame (Internal dia)</td>
<td>56 dia</td>
<td>56 dia</td>
<td>56 dia</td>
</tr>
<tr>
<td>Weight of cover and frame</td>
<td>116 Kg.</td>
<td>116 Kg.</td>
<td>116 Kg.</td>
</tr>
<tr>
<td>Type of Cover &amp; Frame</td>
<td>SFRC</td>
<td>SFRC</td>
<td>SFRC</td>
</tr>
</tbody>
</table>

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 coat of neat cement.

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.

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.

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 as given above.

All Rainwater Collection Chamber shall be of the size 50x45x60cm (internal) with horizontal C.I. grating or SFRC precast Gully Grating as per instructions of Engineer-in-Charge. The grating along with frame shall be of size 500x450mm grating having total Wt. of app. 38 Kg and of approved design and quality as per instruction of Engineer-in-Charge. The remaining details of construction shall be same as stated above for the construction of the Manholes etc.

### 4.5.17 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.
4.5.18 Commissioning

After successful testing of the different sewerage and drainage pipes in parts, the Contractor shall provide all facilities including necessary piping's, labors, tools and equipments etc. for carrying out testing and commissioning of the entire external sewerage and drainage system complete as per requirement in the presence of Client representative/Consultant, wherever and as may be required. Generally, the following test/inspection has to be carried out:

- For any Leaks/seepages in the external sewerage and drainage pipes.
- For checking the functioning of the entire external sewerage and drainage system including rainwater harvesting system and to ensure that the waste water is continuously flowing towards outfall without any intermediate stagnation.
- For the functioning of the valves and accessories etc. by putting ON/OFF the controlling valves of the various diversions in the sewerage and drainage and rain water harvesting system.

4.5.19 Desalting Chamber & Rain Water Harvesting Tank

All Rainwater Collection Chamber shall be of the size 200x100x60cm (internal) complete as per drawing or as instructions of Engineer-in-Charge.

Rain water harvesting pit is constructed preferably 5 to 10m from the permanent structure. The bore will be excavated manually or drilled by reverse direct rotary method up to the water level or as per instruction of Engineer-in-Charge.

The dia of Rain water harvesting pit shall be 3000mm. Pit shall be filled with boulders, gravel and coarse sand.

Bore shall be 250mm dia and pipe shall be 160 OD uPVC 6 kg/cm². The pipe placed in the center of the shaft touching the lowest portion of the pit. The overflow pipe from the desalting chamber is directly connected to the rain water harvesting pit so that the rain water freely enters the pit for recharging. In addition to the inlet pipe from desalting chamber an overflow pipe at the ground level so that any excess water that enters the pit is automatically drained away without damaging the pit.

4.6 Handing Over Procedure

4.6.1 Documents Submission

The Contractor shall before finally handing over the completed work in his scope to the Owner, submit the documents as per the Contract and as directed by the Engineer-in-Charge. Given below the checklist for the reference of the Engineer-in-Charge.

<table>
<thead>
<tr>
<th>Packages</th>
<th>Sanitary Fixtures</th>
<th>Soil, Waste &amp; Vent Pipes</th>
<th>Water Supply System</th>
<th>Sewerage/Drainage System</th>
<th>Water Tanks</th>
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<td>List of inventory</td>
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<td>Training</td>
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<td>Operation Manual</td>
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<td>As built P&amp;I</td>
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<td>Defects Liability</td>
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<td>Period/ Warranty</td>
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<td>Commissioning report</td>
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<td>Test reports/</td>
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<td>Certificates</td>
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<td>List of essential spares</td>
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<td>Address/ Contact nos. of Vendors</td>
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<td>Remarks</td>
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### 4.7 Fire Fighting System

#### 4.7.1 Technical Specification

Work under this sub-head consists of furnishing all Labor, Materials, equipment and accessories necessary and required to completely install the Fire Fighting equipment etc., specified hereinafter and given in the

Without restricting to the generality of the foregoing the work of Fire Fighting System shall include the followings:

- Providing M.S. black steel (Class C) pressure pipe line main including Valves, Fire Hydrants, Excavation for Pipe, Laying of pipe, Painting of pipe and Making Connection to supply system.
- Black Steel Pipe, Mains Laterals, Branches, Valves, Hangers and Appurtenances.
• Portable Fire Extinguishers
• Fire Fighting Pumps, diesel operated pumps, panels and all connected accessories including suction & delivery pipes.
• Testing Commissioning and giving live demonstrations to the various Inspection Authorities and Obtain their “No Objection Certificate” (NOC) for occupation of the building.

4.7.2 General Requirements
All materials shall be of the best quality conforming to the Specifications and subject to the approval of the Engineer-in-Charge.

Pipes and Fittings shall be fixed truly Vertical, Horizontal or in slopes as required in a neat workmanlike manner.

Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause any obstruction in shaft, passage etc. Pipes shall be securely fixed to walls and ceiling by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceilings.

Valves and other appurtenance shall be so located that they are easily accessible for operation, repairs and maintenance.

4.7.3 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:
• Pipes 150 mm dia and below IS: 1239 (Class C) Heavy Class

4.7.4 Pipe Fittings
Pipes and fittings means tees, elbows, couplings, flanges, reducers etc. And all such connecting devices that are needed to complete the piping work in its totality.

Fabricated fittings shall not be permitted for pipe diameters 50 mm and below.

When used, they shall be fabricated, welded and inspected in workshops under supervision of Engineer-in-Charge whose welding procedures have been approved by the TAC as per TAC rule 4102 applicable to hydrant system. For “T” connections, pipes shall be drilled and reamed. Cutting by gas or electrical welding will not be accepted.

4.7.5 Jointing
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 MS forged fittings)

Welding (65 mm dia and above)
Joints between MS pipes and fittings shall be made with the pipes and fittings having "V" groove and welded with electrical resistance welding in an approved manner. 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). The welding machine shall be 3 Phase rectifier of required current and capacity. The vendor for welding will be approved by Engineer-in-Charge.

**Flanges**
Flanged joints shall be provided on:
- Straight runs not exceeding 30 m on pipelines 80 mm dia and above.
- Both ends of any fabricated fittings e.g. bends, tees etc. of 65 mm dia or larger diameter.
- 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.
- Flanges shall be as per IS 6392-1971, Table 17/18 with appropriate number of G.I. nuts and bolts, half threaded of with 3 mm insertion neoprene gasket complete.

**Unions**
Provide Approved type of dismountable unions on pipes lines 65 mm and below in similar places as specified for flanges shall be provided.

4.7.6 **Pipe Protection**
All pipes above ground and in exposed locations shall be painted with one coat of Red Oxide Primer and two or more coats of Synthetic Enamel Paint of approved shade.

All black steel pipes under floors or below ground shall be provided with protection against corrosion by application of 100mm wide and 4mm thick layer of PYPKOTE/MAKPOLYKOTE over the pipe, as per manufacturers specifications.

4.7.7 **Pipe Supports**
All pipes shall be adequately supported from ceiling or walls from existing/new inserts by Structural clamps fabricated from M.S. Structural e.g. Rods, Channels, Angles and Flats as per details given in drawings and specifications. All clamps shall be painted with one coat of red lead and two coats of black Enamel paint.

Where inserts are not provided, the Contractor shall provide anchor fasteners. Anchor fastener shall be fixed to walls and ceilings by drilling holes with Electrical drill in an approved manner as recommended by the manufacturer of the fasteners.

4.7.8 **Testing**
All pipes in the system shall be tested to a hydraulic pressure of 1.5 times of the working pressure or minimum of 15 kg/cm² without drop in the pressure for at least 2 hours.

Rectify all leakages, make adjustment and retest as required.

4.7.9 **Anchor Block**
Contractor shall provide suitable cement concrete, anchor blocks of ample dimensions at all bends, tee connection and other places required and necessary for overcoming pressure thrusts in pipes. Anchor blocks shall be of cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size).
4.7.10 Valves, Gauge and Orifice Plates
Sluice Valves above 65 mm shall be of Cast Iron body and Bronze/Gunmetal seat. They shall conform to type PN 1.6 of IS:780-1980, valves up to 65mm shall be of Gunmetal Full way Valve with wheel tested to 20 kg/cm2 class-II as per I.S: 778 1971. Valve wheels shall be of right hand type and have an arrow head engraved or cast thereon showing the direction for turning open and closing. Non-return valves shall be of Cast Iron body and Bronze/Gunmetal seat. They shall conform to class of IS: 5312 and have flanged ends. They shall be swing check type in horizontal runs and lift check type in vertical runs of piping. They shall not be spring-loaded type.

4.7.11 Internal Hydrants
A cap with chain is provided on one head of the outlet. The hydrant will have an instantaneous pattern female coupling for connecting to Hose Pipe.
The Landing Valve shall be fitted to a Tee connection on the wet riser at the landing.

4.7.12 First-Aid Hose Reel Equipment
First aid hose reel equipment shall comprise reel, hose guide fixing bracket hose tubing globe valve, stopcock and nozzle. This shall conform to IS:884 - 1969. The hose tubing shall confirm to IS:1532-1969.
The hose tubing shall be 20 mm dia and 36.5m long. The GM nozzle 5mm and globe valve shall be of 20 mm size.
The fixing bracket shall be of swinging type. Operating instructions shall be engraved on the assembly. This heavy duty mild steel and cast iron brackets shall be conforming to IS: 884 - 1969. The first-aid hose reel shall be connected directly to the MS pipe riser taken independently from ring.

4.7.13 Hose Pipes
Two numbers Hose Pipes shall be rubber lined woven jacketed and 63mm in dia. 15m long. They shall confirm to type A (Reinforced rubber lined) of IS:636 - 1979. The hose shall be sufficiently flexible and capable of being rolled.
Each run of hose shall be complete with necessary coupling at the ends to match with the landing valve or with another run of hose pipe or with branch pipe. The couplings shall be of instantaneous spring lock type. This shall be conforming to IS: 903.

4.7.14 Branch Pipes
Branch pipe shall be of Gunmetal 63 mm dia and be complete with male instantaneous spring lock type coupling for connection to the hose pipe. The branch pipe shall be externally threaded to receive the nozzle.
4.7.15 **Nozzle**

The nozzle shall be of Gunmetal 20 mm in (internal) diameter. The screw threads at the inlet connection shall match with the threading on the branch pipe. The inlet end shall have a hexagonal head to facilitate screwing of the nozzle on to the branch pipe with nozzle spanner.

End Couplings, Branch pipe, and Nozzles shall conform to IS:903 - 1985.

Two C.P hoses of 15m length with couplings shall be provided with each External (Yard) Hydrant. Two RRL hoses of 15m length, as specified, with couplings shall be provided with each Internal Hydrant. One nozzle and one branch pipe with coupling shall be provided with each Yard Hydrant and Internal Hydrant.

4.7.16 **Hose Cabinet**

The internal hose cabinet shall accommodate the Hose pipes, branch pipe, Nozzle First aid Hose Reel and Hydrant Outlets and shall be fabricated from 2 mm thick or 14 mm gauge MS/aluminum sheet. The overall size shall be 2100x900x715 mm, or as specified in the Architectural details. This shall have lockable centre opening glazed doors as per the requirement and as per Architectural details. Where the niche for wet riser is provided with shutters, separate hose cabinet as above may be dispensed with.

The hose cabinet shall be painted red and stove enameled and woods FIRE written in front glazed portion.

4.7.17 **Fire Brigade Inlet Connections**

Fire Brigade Inlet connection shall be provided near the pump house and to the wet riser system as specified, for the following purposes:

- Fire Brigade suction connection for fire static tank with provision of foot valve.
- Fire brigade inlet connection to fire static tank.
- Fire brigade inlet connection to the wet riser system. Each connection shall be provided with similar dia of Sluice valve and Non return valve.

The locations of this Fire brigade connection shall be suitably decided with the approval of Consultant/Landscape Architect and with a view that these are easily accessible to the fire brigade, without any possible Hindrance.

4.7.18 **Hydraulic Siren**

A siren shall be provided in the system, to indicate the flow of water in the wet riser system. Alternative arrangements may also be adopted. This shall be turbine type.

4.7.19 **Valve Chambers**

Contractor shall provide suitable Brick Masonry Chamber in cement mortar 1:5 (1 cement: 5 coarse sand) on cement concrete foundations 150 mm thick in 1:5:10 mix (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) 15 mm thick 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.
Valve chambers shall be of following size:
- For depths 100 cm and beyond 90x90x100 cm

4.7.20 Portable Fire Extinguisher
Portable fire extinguishers shall be provided as per the drawing and shall confirm to IS:15683.
- Dry Chemical powder type of 5 Kg. Capacity as per (IS:15683)
- CO2 type of 4.5 kg capacity as per (IS:15683)

4.7.21 Shop Drawings & Specifications
The Contractor shall submit to the Consultant two copies of Shop Drawings for Fire Fighting 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.

Shop drawings shall be submitted for the following conditions:
- Structural supports/hanging/laying and jointing details for all types of pipes as required.
- Fire Fighting layout plans as required and for any changes in the layout of Fire Fighting/Architectural drawings.

The Contractor can only commence the work after the approval of above documents by Consultant.

4.8 Water Supply/Fire Fighting Pumps & Equipments and Water Treatment Units etc.

4.8.1 Pumps and Water Treatment Equipment
Work under this sub-head consists of furnishing all labor, 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.

Without restricting to the generality of the foregoing, the work of pumps and water treatment equipment shall include the followings:

- Raw water pumps.
- Fixed speed hydronumatuc transfer pumps for Domestic water.
- Garden Hydrant Pumps.
- Sump pumps for disposal of sewage and drainage.
- Water treatment unit consisting of filters, softener and chlorination etc.
- Fire pump.
- Motor control panels, power and control cabling and allied electrical works.
- Pipes, valves, accessories, hangers, supports, delivery and suction feeders and connection to proposed pipe work.

4.8.2 Water Supply Pumps (Raw Water / Domestic Water / Flushing/Garden Hydrant / Hot Water Recirculation Pump)
Water supply pumps shall be suitable for clean water. Pumps shall be multistage, monoblock vertical centrifugal pumps with stainless steel body and stainless steel impeller, stainless steel shaft and coupled to a TEFC electric motor by means of a flexible coupling. Each pump should operate a curve 10m below specified head.

Pump and motor shall be mounted on a common M.S. structural base plate or as required as per site conditions.

Each pump shall be provided with a totally enclosed fan cooled induction motor.

Each pumping set shall be provided with a 150mm dia or of suitable size gunmetal "Burden" type pressure gauge with gunmetal isolation cock and connecting piping.

Provide vibration-eliminating pads appropriate for each pump.

Provide rate of flow measuring meter with bypass arrangement with every set of pumps.

All water supply pumps shall be provided with mechanical seals.

Domestic water supply pumps shall be packaged type skid mounted hydro pneumatic system with fixed speed system. Complete system to be mounted on a common base frame.

Pumps shall be multistage, monoblock vertical centrifugal pumps with stainless steel body and stainless steel impeller, stainless steel shaft and coupled to a TEFC electric motor by means of a flexible coupling. Each pump should operate a curve 10m below specified head.

Pressure vessel of non corrosive FRP composite construction lined with NSF and/or FDA listed material, like high density polyethylene with fully replaceable polyurethane. Air cell burst pressure of minimum of 5 times the vessel operating pressure and cycle tested for 2,50,000 cycles. No. and capacity of Pressure Vessel As per manufacturer recommendation.

Pump and motor shall be mounted on a common M.S. structural base plate or as required as per site conditions.

Each pump shall be provided with a totally enclosed fan cooled induction motor.

Each pumping set shall be provided with a 150mm dia or of suitable size gunmetal "Burden" type pressure gauge with gunmetal isolation cock and connecting piping.

Provide vibration-eliminating pads appropriate for each pump.

Provide rate of flow measuring meter with bypass arrangement with every set of pumps.

All water supply pumps shall be provided with mechanical seals.
Pumps shall have Control Panel with programmable logic controller (PLC) for cyclic operation of pumps. Pump working sequence should change after every operation. Contractor overload relays and MCBs should confirm to IEC 898 – 1995/ specifications. Blinking indications for pumps start, trip, low level trip, and health supply should be provided in the panel along with the ammeter & voltmeter. Control panel should also consist of cooling fan.

4.8.3 Fire Fighting Pumps

Terrace Pumps
Pumping sets shall be single stage horizontal centrifugal single outlet with cast iron body and dynamically balanced bronze impellers. Connecting shaft shall be of stainless steel with bronze sleeve and grease-lubricated bearings. Pumps shall be connected to the drive by means of spacer type love-joy coupling which shall be individually balanced dynamically and statically.

The coupling joining the prime mover with the pump shall be provided with a sheet metal guard.

Pumps shall be provided with approved type of mechanical seals.

Pumps shall be capable of delivering 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 not exceed 120% of the rated head.

The System shall meet the requirements of the National building Code 2016 (NBC).

Necessary 'Y' strainer on the suction side and pressure gauge with GM cocks on the delivery side including bypass arrangement (with 50 valve and up to 5M G.I. Medium pipes) for periodical testing of the working of the pumping set shall be provided.

Pump shall be mounted on common base frame fabricated from MS channel as per manufacturer's specification.

Suitable RCC Pump-foundations as per manufacturer's design and 4 nos. Dunlop (cushy foot) heavy duty Antivibration mounting pads shall be provided.

Detail of Pumps as below :

a) Terrace pumps – Cap 450 lpm, Head 70 M, HP 10 HP app, Nos 1 Nos

Motors for Electric Driven Pumps

Electrically driven pumps shall be provided with totally enclosed fan cooled induction motors.
Motors for fire protection pumps shall be at least equivalent to the horse power required to drive the pump at 150% of its rated discharge and shall be designed for continuous full load duty and shall be design proven in similar service.

Motors for fire pumps shall meet all requirements and specifications of the tariff advisory committee.

Motors shall be suitable for 415 volts, 3 Phase, 50 cycles A.C supply and shall be designed for 33°C ambient temperature. Motors shall conform to IS: 325.

Motors shall be designed for two start system.

Motors shall be capable of handling the required starting torque of the pumps.

Contractor shall provide heating arrangements for the main fire pump motor to ensure that motor windings shall remain dry.

**Air Vessel for Fire Pumps**

Provide an air vessel fabricated from 10mm 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 gunmetal water level gauge and 25mm sockets for pressure switches. The vessel shall be 450mm in dia and 2000 mm high and tested to 10.0Kg/cm2 pressure.

The fire pumps shall operate on drop of 1 Kg/cm2 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.

**Operating Conditions for the Service Pumps**

<table>
<thead>
<tr>
<th>Fire Service Pump</th>
<th>Nos.</th>
<th>Cut in Pressure</th>
<th>Cut Out Pressure</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrace Pump</td>
<td>One</td>
<td>6.7 kg/cm²</td>
<td>Push button manual</td>
<td>To auto start on pressure switch on air vessel and manual off.</td>
</tr>
</tbody>
</table>

**4.8.4 Cables**

Contractor shall provide all power control cables from the motor control center to various motors, level controllers and other control devices.

Cables shall conform to IS: 1554 and carry ISI mark.

Wiring cables shall conform to IS 694.

All power and wiring cables shall be aluminum conductor PVC insulated armored and PVC sheathed of 1100 volts grade.

All control cables shall be copper conductor PVC insulated armored and PVC sheathed 1100 Volt grade.
All cables shall have stranded conductors. The cables shall be in drums as far as possible and bear manufacturer's name.

All cable joints shall be made in approved manner as per standard practice.

4.8.5 Cable Trays
Contractor shall provide M.S slotted cable trays at locations as shown on the drawings.

Cable trays shall be supported from the bottom of the slab at intervals of 60cms at both ends by anchor fasteners.

4.8.6 Earthing
There shall be an independent earthing station. The earthing shall consist of an earth tape connected to an independent plate made of copper or G.I. having a conductivity of not less than 100% international standard. All electrical apparatus, cable boxes and sheath/armor clamps shall be connected to the main bar by means of branch earth connections of appropriate size. 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 riveted and sweated.

Earth plates shall be buried in a pit of 1.20x1.20M at minimum depth of 3M below ground. The connections between main bar shall be made by means of three 10mm brass studs and fixed at 100mm centers. The pit shall be filled with coke breeze, rock salt and loose soil. A G.I. pipe of 20mm dia with perforations on the periphery shall be placed vertically over the plate to reach ground level for watering.

A brick masonry manhole 30x30x30cm 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.

4.8.7 Control Panels / Starters
Switch board cubicles of approved type shall be fabricated from 16-gauge M.S. sheet with dust and vermin proof construction. It shall be painted with powder-coated finish of approved make and shade. It shall be fitted with suitable etched plastic identification plates for each motor. The cubicle shall comprise of the followings:-

- Incoming main isolation MCCB of required capacity.
- Fully Aluminum taped Bus Bar of required capacity.
- Isolation MCCB one for each motor.
- Fully automatic as specified D.O.L/Star Delta starters suitable for motor H.P. with push buttons one for each motor and on/off indicating neon lamps. (DOL up to 7.5 HP and Star Delta from more than 7.5 H.P)
- Single phase preventer of appropriate rating for each motor.
- Panel type ampere meters one for each motor with selector switch.
- Panel type voltmeter on incoming main with rotary selector switch to read voltage between phase to neutral and phase-to-phase.
- Neon phase indicating lamps for incoming main and on/off indicating lamps for each motor.
- Rotary switch for manual or auto operation for each pump (manual/auto off).
- Fully taped separate aluminum bus bars of required capacity and with required outlets.
- Space for liquid level controllers as specified + 1 extra space.
- The panel shall be pre-wired with color-coded wiring. All interconnecting wiring from incoming main to switch gear, meters and accessories within the switchboard panel.
- Provision of main incoming cables from the top of the panel.

All switch gears and accessories shall be of approved make such as "Siemens, Larsen & Toubro" or equivalent.

Switchboard cubicles shall be floor or wall mounted type as recommended by manufacturers. All floor-mounted switchboards shall rest on minimum 225mm high platform. The contractor shall provide the shop drawings for base and panels.

4.8.8 **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 manufacturer's details.

4.8.9 **Illuminated Facsimile Annunciator Panel**

Scope

Scope of this section comprises the supply, installation, testing and commissioning of illuminated facsimile annunciation panel.

**Illuminated Facsimile Enunciator**

Illuminated facsimile enunciator shall be provided with facsimile of the building, constructed of acrylic panels of suitable dimensions, showing the Basement, Ground floor plans and section showing the location of Zonal Panels on each typical floor, entry points, various facilities shown with enamels in various colors.

Alarm lights to indicate fire location shall be arranged within the acrylic panel and shall be either automatically lighted by operation of any automatic fire detection devices or manual station, or by control of push button incorporated in the control desk.

Indicator of each building or facility shall include two lamps connected in parallel and so arranged that the failure of either of the lamps is readily apparent when a call or test is made.

Power for the Enunciator shall be supplied from the power supply for the control desk.

Representation of the various plans/Drawings on the acrylic of the Enunciator shall be by negative film processing with colored Discrimination of various zones for which the drawings shall be furnished for approval.

4.8.10 **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.

4.8.11 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, as per I.S: 1239 and valves shall be cast iron double flanged sluice valves on SOUNDERS pattern with C.I. body and Neoprene rubber diaphragm (Suggested make LABLINE, NKI or equivalent).

4.8.12 Accessories
- Each filter shall be provided with following accessories:-
- Air release valve with connecting piping.
- 150mm dia dial burden type gunmetal pressure gauges with gunmetal isolation cock and connecting piping on inlet and outlet.
- Sampling cocks on raw water inlet and filtered water outlet.
- Individual drain connection with gunmetal full way valve.
- Connection with valve for air scouring.

4.8.13 Water Softener
Softener shall be designed to give zero commercial hardness. Softener shall be with cation exchange resins.

Softener vessel shall be of mild steel plate with dished ends and self supporting arrangement. Vessel shall be suitable for a working pressure. 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 coat of red oxide and two or more coats of synthetic paint to give an even shade.

The vessel shall have an internal collecting and distribution system of manufacturer's design.

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 M.S. medium duty, as per I.S: 1239 and valves shall be cast iron double flanged sluice valves on SOUNDERS pattern, with C.I. body and Neoprene rubber diaphragm (suggested make LABLINE, NKI or equivalent).

One set of hydraulic injector with control valve, brine delivery pipes with adjustable indicator.

One cylindrical salt saturator and measuring tank of M.S. rubber lined having a capacity of a minimum of two regenerations for.
One orifice board for indicating wash and rinse rate to be fitted in drain sump.
One charge of supporting gravel, sand and “cation” resin in requisite quantity. Resin shall be Indian 220 or approved equivalent make.

One water testing kit with instructions for testing water samples.

4.8.14 Piping

Pipes for suction and delivery shall be galvanized/M.S tube (heavy duty) confirming to I.S:1239 up to 150mm dia and as per I.S:3589 for dia 200mm and above. The M.S flanges shall confirm to I.S:6392-1971.

Gate valve and check valve above 65mm dia shall be C.I. double flanged conforming to I.S:780 manufactured by the reputed manufacturers or C.I. double flanged butterfly valves.

Full way and check valves 65mm dia and below shall be gunmetal tested to 20Kg/cm2 pressure certified and conforming to I.S:778.

Suction strainer or foot valves shall be C.I., confirming to I.S:4038-1979.

4.8.15 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.

4.8.16 Testing

All G.I pipes (except fire pipe) shall be tested hydrostically for a period of 30 minutes to a pressure of 7 Kg/cm2 without drop in pressure and all G.I pipes for fire shall be tested hydrostically for a period of 30 minutes to a pressure of 10 Kg/cm2 without drop in pressure.

4.8.17 Guarantee

The contractor shall submit a warranty for all equipment, materials and accessories supplied by him against manufacturing defects, malfunctioning or under capacity functioning.

The form of warranty shall be as approved by the Engineer-in-Charge.

The warranty shall be valid for a period of one year from the date of commissioning and handing over.

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.

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.
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<th>S.No.</th>
<th>Material</th>
<th>Approved Makes/Brands/manufacturer</th>
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<tr>
<td>1</td>
<td>Ordinary Portland Cement / Portland Pozzolona Cement</td>
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<td>White Cement</td>
<td>Birla Cement, J. K White, La Farge</td>
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<td>M.C.Bauchemie, Fosroc, Pidilite, Asian Laboratories, Ultracon</td>
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**PLUMBING & SANITARY**

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**FIRE FIGHTING**

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ANNEXURE-B
EQUIPMENTS SCHEDULE FOR 250 KVA DG SET

DIESEL GENERATOR SETS:

1.0 DIESEL ENGINE

a) Capacity : 250 KVA
b) Speed : 1500 rpm
c) No. of cylinders : 6 Nos. Cylinders
d) Accessories : Fly wheel to suite flexible coupling.
   ELECTRONIC GOVERNOR / AS PER CUMMINS PRACTICE
   Lubricating gear oil pump, oil tank, oil filter and high oil pr.
   Relief valve, oil cooler, etc.
   Fuel injection pump and fuel oil filter.
   Starting motor, battery leads and stand 2X12V lead acid
   batteries, battery charger (Suitable battery AH capacity)
   Turbo charger
   Air cleaner and air suction pipe
   Exhaust manifold with flexible bellow.
   Hospital Grade silencer
   Air Cooling system complete with engine driven fan, to
   connect diesel engine to Radiator with thermostat.
   Coupling with guard
e) Controls : Automatic ‘stop’ device if any of the following parameters are
   varied beyond upper/ lower limits, with visual indication.
   Low- lube oil pressure.
   Cooling water temperature (High)
   Over- Speed
f) Digital Instrument Panel : Integral mounted complete with wiring and connections
   (for engine) and connections and comprising of :-
   Starting switch with key.
   Coolant temperature gauge
   Lube oil pressure gauge.
   Battery charging ammeter
Hour- Meter
RPM indicator
Visual alarm to pin-point the fault on tripping.

g) **Isolation control panel:**

The control panel shall be totally enclosed dust and vermin construction with pedestal for floor mounting. The panel shall be made of 14G CRCA sheet duly treated with derusting, degreasing primer coated and backed enamel painted with approved synthetic enamel paint. The panel shall be front operated with hinged doors and provided with heavy duty square section rubber gasket. The panels shall have top and bottom detachable cable gland plates. The control panel shall provide the following.

i) **Circuit breaker** : 1 No. 500A 4P MCCB (36kA)

ii) **Metering & indication** :

- 1 set. of R/ Y/ B phase indicating lamp with control MCB's.
- 1 No. (0 - 500A) Digital Ammeter with built-in selector switch and CT's.
- 1 No. (0 - 500 V) Digital Voltmeter with built-in Selector switch & control MCB's.

h) **Fuel Day tank & piping** : Min. 450 Ltrs. Inbuilt fuel day tank with flexible hoses shall be provided as standard scope of supply.

2.0 **ALTERNATOR**

a) **Capacity** : 250 KVA

b) **Speed** : 1500 rpm

c) **Type** : Brush less. Self-excited and self-regulated.

d) **Winding** : Copper

e) **Class of insulation** : Class ‘H’ (tropicalised)

f) **Exciter** : IP- 23

g) **Bearing** : Single Bearing - Heavy duty pre-lubricated cartridge type

h) **Ventilation** : Centrifugal fan.

i) **Terminals** : Suitable for terminate to 2Nos. 3.5 core 150 sq. mm Alu. XLPE Cable
3.0 ACOUSTIC ENCLOUSER FOR 250 KVA DG SET:

3.1 THICKNESS OF SHEET - Min. 16 G
High Class sheet metal fabricated enclosure for reducing the noise level of DG set & also acts as a weather proof housing. Genset will be an integral part of acoustic enclosure & whole construction will be on multi-fold sheet channels & sections. Enclosure construction is fully bolted keeping in view the major service requirements all doors are provided with specially designed hinges & lockable handles, battery is housed inside the enclosure.

3.2 ACOUSTIC MATERIAL
Rock wool in the form of slabs of 75-100 mm thickness of suitable density compressed along with 0.6 mm MS perforated sheet. The sheet is pasted on the inside of the outer wall for anti droning effect, 0.6 mm RP fibre tissue sandwiched between Rock wool layers. Specification of Rock wool confirms to IS 8183.

Further to increase the life of Acoustic material resin coated fibre glass tissue is provided on exposed surface of Rock wool slabs and the panels are supported by perforated sheets.

3.3 SURFACE TREATMENT
Weather proof and anti-corrosion treatment provided to the entire structure i.e. Powder coated & dependability and longer life.

* Surface treatment should be with minimum nine tank process.

3.4 VENTILATION
Acoustic enclosure is designed in such a way that there are no hot pockets around engine and it is provided with suitable designed engine radiator / or temperature to rise inside canopy not more than 5 – 7 deg.C., above ambient temperature besides this provisions are made in cooling air within Max. + 2⁰

To achieve optimal output and minimum sound level from the DG set, suitable openings with acoustic hoods are provide for increasing the inflow of air required for combustion & ventilation. Air intake system as per the recommendations and engine requirement are provided.

* Acoustic hoods with noise splitters provided to block and reduce the sound leakage.

* The sound control system designed to suppress the sound level 75 db at 1 meters distance. As per requirement of Pollution Board.

3.5 SILENCER
Specially designed low noise silencer shall be used. Silencer & engine exhaust outlet, Connected with flexible SS below.

3.6 VIBRATION ISOLATION
To avoid transfer of vibration from Genset to enclosure & surrounding specially designed vibration isolators shall be used.

NOTE – DG set shall comply with ECBC & CPCB-II norms in all terms like engine, alternator, Fuel consumption, Exhaust system & its height, acoustic enclosure & Sounds.
ANNEXURE-B1
EQUIPMENTS SCHEDULE FOR 160 KVA DG SET

DIESEL GENERATOR SETS:

1.0 DIESEL ENGINE

a) Capacity : 160 KVA
b) Speed : 1500 rpm
c) No. of cylinders : 6 Nos. Cylinders
d) Accessories : Fly wheel to suite flexible coupling,

   ELECTRONIC GOVERNOR

   Lubricating gear oil pump, oil tank, oil filter and high oil pr.
   Relief valve, oil cooler, etc.
   Fuel injection pump and fuel oil filter.
   Starting motor, battery leads and stand 2X12V lead acid
   batteries, battery charger (Suitable battery AH capacity)
   Turbo charger
   Air cleaner and air suction pipe
   Exhaust manifold with flexible bellow.
   Hospital Grade silencer
   Air Cooling system complete with engine driven fan, to
   connect diesel engine to Radiator with thermostat.
   Coupling with guard

e) Controls : Automatic ‘stop’ device if any of the following parameters are
   varied beyond upper/ lower limits, with visual indication.
   Low- lube oil pressure.
   Cooling water temperature (High)
   Over- Speed

f) Digital Instrument Panel
   (for engine) : Integral mounted complete with wiring and connections
   and connections and comprising of :
   Starting switch with key.
   Coolant temperature gauge
   Lube oil pressure gauge.
   Battery charging ammeter
   Hour- Meter
RPM indicator

Visual alarm to pin-point the fault on tripping.

g) **Isolation control panel:**

The control panel shall be totally enclosed dust and vermin construction with pedestal for floor mounting. The panel shall be made of 14G CRCA sheet duly treated with derusting; degreasing primer coated and backed enamel painted with approved synthetic enamel paint. The panel shall be front operated with hinged doors and provided with heavy duty square section rubber gasket. The panels shall have top and bottom detachable cable gland plates. The control panel shall provide the following.

i) **Circuit breaker** : 1 No. 320A 4P MCCB (25kA) with built in over Load & Short circuit Protection of rating.

ii) **Metering & indication** :

: 1 set. Of R/ Y/ B phase indicating lamp with control MCB’s.

: 1 No. (0 - 320A) Digital Ammeter with built-in selector Switch and CT’s.

: 1 No. (0 - 500 V) Digital Voltmeter with built-in Selector switches & controls MCB’s.

h) **Fuel Day tank & piping** : Min. 290 Ltrs. Inbuilt fuel day tank with flexible hoses shall be provided as standard scope of supply.

### 2.0 ALTERNATOR

a) **Capacity** : 160 KVA

b) **Speed** : 1500 rpm

c) **Type** : Brush less. Self-excited and self-regulated.

d) **Winding** : Copper

e) **Class of insulation** : Class ‘H’ (tropicalised)

f) **Exciter** : IP- 23

g) **Bearing** : Single Bearing - Heavy duty pre-lubricated cartridge type

h) **Ventilation** : Centrifugal fan.

i) **Terminals** : Suitable for terminate to 1No. 3.5 core 240 sq. mm Alu. XLPE Cable
3.0 ACOUSTIC ENCLOUSER FOR 160 KVA DG SET:

3.1 THICKNESS OF SHEET- Min.16 G
High Class sheet metal fabricated enclosure for reducing the noise level of DG set & also acts as weather proof housing. Genset will be a integral part of acoustic enclosure & whole construction will be on multi-fold sheet channels & sections. Enclosure construction is fully bolted keeping in view the major service requirements all doors are provided with specially designed hinges & lockable handles, battery is housed inside the enclosure.

3.2 ACOUSTIC MATERIAL
Rock wool in the form of slabs of 75-100 mm thickness of suitable density compressed along with 0.6 mm MS Perforated sheet. The sheet is pasted on the inside of the outer wall for anti droning effect, 0.6 mm RP Fiber Tissue sandwiched between Rock wool layers Specification of Rock wool confirms to IS 8183.

Further to increase the life of Acoustic material resin coated fiber glass Tissue is provided on exposed surface of Rock wool slabs and the panels are supported by perforated sheets.

3.3 SURFACE TREATMENT
Weather proof and anti-corrosion treatment provided to the entire structure i.e. Powder coated & dependability and longer life.

* Surface treatment should be with minimum nine tank process.

3.4 VENTILATION
Acoustic enclosure is designed in such a way that there are no hot pockets around engine and it is provided with suitable designed engine radiator / or temperature to rise inside canopy not more than 5 – 7 deg.C., above ambient temperature besides this provisions are marked in cooling air within Max.+ 20

To achieve optimal output and minimum sound level from the DG set, suitable openings with acoustic hoods are provide for increasing the inflow of air required for combustion & ventilation. Air intake system as per the recommendations and engine requirement are provided.

* Acoustic hoods with noise splitters provided to block and reduce the sound leakage.

* The sound control system designed to suppress the sound level 75 db at 1 meters distance. As per requirement of Pollution Board.

3.5 SILENCER
Specially designed low noise silencer shall be used. Silencer & engine exhaust outlet, Connected with flexible SS below.

3.6 VIBRATION ISOLATION
To avoid transfer of vibration from Genset to enclosure & surrounding specially designed vibration isolators shall be used.

NOTE –DG set shall comply with ECBC & CPCB-II norms in all terms like engine, alternator, Fuel consumption, Exhaust system & its height, acoustic enclosure & Sounds.
CONSTRUCTION OF INCUBATION CENTRE FOR SOFTWARE TECHNOLOGY PARK OF INDIA (STPI)

AT

PLOT NO. 4&5, SECTOR-7, GIDA, GORAKHPUR

VOLUME 2 – Part VI
(SITC OF PASSENGER LIFTS)
TECHNICAL SPECIFICATIONS OF PASSENGER LIFTS

1.0 SCOPE OF WORK

These specifications cover the details of 1 no. 8 persons / 544 kgs. capacity Passenger lifts including suitable Brake release tools to be designed, supplied, inspection as may be necessary before despatch, delivery at site, installation, testing, commissioning and handing over to STPI and the defects liability for a period of 1 year after completion of all works & handing over to client. Scope of work shall also include AMC (Annual maintenance contract) for 5 years after one year of defect liability period after handing over to client.

These specifications shall be read in conjunction with the General Conditions of Contract, Additional Conditions of Contract.

2.0 GENERAL

The equipment and installation covered by these specifications shall conform to codes of practice in force and highest standards of workmanship and materials. This work shall be done in accordance with the provisions of the Local Lifts Authority rules and shall also conform to requirements of local municipal by laws, and subsequent provisions, as also any state or local Act in force and latest Indian Standard 14665 and all latest applicable BIS, NBC code and ‘CPWD General Specifications for Electrical Works (Part III, Lifts & Escalators) 2003’.

The Entire electrical installation shall be done in accordance with the Indian Electricity Act 2003, Indian Electricity Rules 1956 as amended to-date. The Electrical wiring shall strictly comply with IS:732 and latest applicable BIS and NBC code. The electrical works shall also conform to CPWD General Specification for Electrical Work Part-I (Internal) 1994 and Part-II (External) 1994 as amended up to date.

The Contractor shall follow all Statutory Requirements as well as best trade practices in the manufacture & installation of lifts. The Contractor shall arrange to obtain the statutory approval of the Inspectorate of Lifts as may be required for commissioning of the lifts and handover for operation after satisfactory tests.

3.0 DRAWINGS

Before commencing work, the Contractor shall prepare and submit all drawings for individual lifts in required nos. necessary to show the general arrangement and details of lift installation, electrical etc. These drawings must be approved by the EPIL / STPI before installation and shall become part of the contract.

The Contractor shall submit 4 (four) copies of all working drawings showing pit, hoistway and machine room layouts clearly indicating and specifying all connected structural, electrical and architectural works including imposed structural static / dynamic loads (including breaking load on guides, reaction of buffers on lift pits, reaction on support points in machine room, lift well etc.) and electrical ratings including calculations for selection of kW rating of motor. Within 10 days of receipt of letter of award of contract, the Contractor shall obtain from the EPIL / STPI all the information he needs to prepare his drawings and shall have any interaction with the EPIL / STPI to finalise all parameters and data for design. The Contractor will be responsible for any discrepancies, errors and omissions in the drawings or particulars.
submitted by him even if these have been approved by the EPIL / STPI. On approval of these drawings (within 2 weeks of submission of full documentation), the Contractor shall submit 8(eight) copies of approved working drawings incorporating corrections / comments, if any, and shall immediately commence work.

On completion of work, the contractor shall supply four sets of CD’s and 8 (eight) copies of the detailed wiring diagram, ‘As built’ drawings and equipment operation & maintenance manuals and original certificates from ‘Inspector of Lifts’ for all the lifts. Further, a copy of such detailed diagram and a set of instructions for evacuation of passengers in case of breakdown of the lifts shall be framed and installed in the respective machine room by the Contractor.

The Contractor shall carry out all the work strictly in accordance with drawings, details and instructions of EPIL / STPI.

4.0 WORKS TO BE ARRANGED BY EPIL / STPI

The following items shall be provided to the Lift Contractor under instructions of the Department to suit the requirements of the lift Contractor.

i. Hoistways, machine rooms and pits of specified dimensions (within normal building tolerances).

ii. Floor, wall and ceiling finishes in hoistways, pits and machine rooms; including painting (except painting of equipment and materials supplied by lift Contractor) and waterproofing, as well as doors and windows in machine room.

iii. Cables from main L.T. Panel Board through the hoistways terminating in and including individual Main Switches of required rating for 3 phase and single phase supply in Machine Rooms including necessary earthing.

iv. Free 3 phase power supply for group testing and commissioning of lifts after erection is completed.

v. Lighting installation within machine rooms as required by the lift Contractor including 1-phase main switch with ELCB at machine room.

vi. The equipment shall be suitable to operate on 415 Volts 3 phase, 4 wires, 50 Hz. A.C. supply with a variation of $\pm 10\%$ in Volts and $\pm 5\%$ in frequency respectively. The supply for illumination and single phase equipment shall be 230 Volts A.C.

vii. Lighting installation within hoistways and pits as required by the lift Contractor including 1-phase main switch at machine room.

viii. Ventilation system of machine rooms with minimum 18” heavy duty exhaust fan in each machine room as per the requirement of NBC / BIS codes.

ix. Providing of hoisting beam in the machine room for hoisting of equipment during erection and to facilitate maintenance in future.
5.0 LIFTS CONTRACTOR’S RESPONSIBILITIES: ANCILLARY WORKS

i. All cabling, wiring and earthing from 3-phase main DB in machine room to Lift Contractor's equipment.

ii. All steel items i.e. machine beam/bases, pedestals/ bearing plate in the machine room, separators wherever required and buffer support channels, vertical iron ladder in lift and structural steel supports and brackets for the installation in etc., to suit the sizes of the hoistways.

iii. Sill tracks including sill supports, supporting protection at all landings.

iv. Screen guards, facia plates and other protection for installation.

v. To carry out minor civil work, such as chipping & making openings in slabs, grouting of foundation bolts in shaft, pit and machine room, modification and making rail bracket, hall buttons indicators and laying of sills in positions. Or any other work required for smooth operation/ commissioning of lifts. All chiselling and cutting of pockets and making good. (All cutting shall be as approved by EPIL / STPI).

vi. Ensuring safety against accidents including barricading all openings and caution signs.

vii. Scaffolding and other Tools & Tackles required for installation in the hoistway required for erection of lifts.

viii. All other items necessary for satisfactory execution & completion of works, whether specified or not.

ix. Power shall be provided at incoming of main DB for lifts. Main DB in the machine room shall be provided by the lift contractor. From main DB to lifts, cables shall be in the scope of lift contractor. However, lighting for machine room shall be done by others.

x. Trap doors, floor gratings, steps / ladders and openings in machine rooms and ladders for pits as required by the lifts Contractor. Contractor shall furnish the details of these items in the layout drawing for lifts to submitted after award of the job.

xi. Temporary power supply connection(s) for erection work shall be arranged by the lift Contractor.

6.0 SOUND REDUCTION

The Contractor shall provide necessary sound reduction materials, such as rubber pads/ anti vibration pads of proper density to effectively isolate the machine from the machine beams and/or flooring.

Noise level inside cars and in the machine room shall be maintained at minimum levels as laid down in the relevant codes and in any case not more than specified under PERFORMANCE PARAMETERS.
7.0 Traction Machine

The machine shall be worm geared traction type with motor (steel worm, bronze gears, steel sheave shaft & Ferro molybdenum sheave), electro-mechanical type of brake and driving sheave mounted in proper alignment on a single heavy cast iron base or steel bedplate.

The worm shaft shall be fitted with roller bearings to take end thrust. The sheave shaft shall also be fitted with roller bearings to ensure proper alignment. All shafts shall be provided with well-designed keys.

Rotating parts shall be statically and dynamically balanced.

The drive sheave shall be designed with machined V-grooves to ensure adequate traction with minimum wear on rope. All sheaves including deflector sheaves, where used, shall conform to I. S. 14665 (Part 4 section 3)

Adequate and dust-proof lubrication shall be provided for all bearings and worm gears.

The brake shall be suitably curved and provided with fire proof friction lining. The operation of brake shall be smooth, gradual and with minimum noise. The brake shall be designed to be of adequate size and strength to stop and hold the car at rest with rated load. The brake shall be capable of operation automatically by various safety devices, current failure and by the normal stopping of the car. The brake shall be released electrically. It shall also be possible to release the brake manually so as to move the lift car in short stops. Suitable Brake release tools (total 3 nos.) shall be supplied and stored in the machine rooms.

For manual operation of lifts, up & down direction of the movement of the car shall be clearly marked on the motor or traction machine. A warning plate in bold signal red colour to switch off the mains supply before releasing the brake and operating the wheel shall be prominently displayed.

8.0 Hoist Motor

The motor shall be suitable for 415 Volts +10% to –20%, 50 Hz. ± 5%, 3 Phase A.C. Supply. The motor must be designed for arduous lift duty, rapid reversals and constantly repeated starts & stops as defined in the relevant codes of practice. All windings must be heavily insulated, adequately impregnated for tropical climate and mechanically strengthened and must be specifically designed to have a high starting torque and low starting current characteristics within the limits acceptable to electricity supply co. requirements and I.E. Rules. The motor shall be designed in such a way as to withstand occasional overloading above its rated capacity and shall have overload protection. The motor shall have good speed regulation under different conditions of load and shall be designed to give a noiseless and vibration-free operation. Insulation shall be class F.

9.0 Motor Control and Drive

The lift motor shall be controlled by a variable voltage variable frequency (V.V.V.F.) micro-processor control system which shall control and monitor every aspect of lift operation at all stages of the car motion cycle on real time basis.
The A.C. V.V.V.F. drive system shall control A.C. voltage and frequency concurrently with the hoist motor to regulate the lift’s actual performance to match closely the ideal speed pattern, obtain maximum efficiency of operation and provide a very smooth ride.

Frequency shall range fully between zero and rated value.

The Controller shall be provided with a self diagnostic programme to keep downtime to a minimum possible.

The controller shall intelligently adjust door times in response to car calls, hall calls and “Door Open” button operation.

An Inspector’s changeover test switch and set of test buttons shall be provided in the controller. Operation of the Inspector’s changeover switch shall make both the car and landing buttons inoperative and permit the lift to be operated in either direction from machine room for test purposes by pressing corresponding test buttons in the controller. It shall not, however, interfere with the emergency stop switches inside the car or on the top of the car.

10.0 GUIDES AND FASTENINGS

i. Guide-rails for car and counterweight shall consist of machined mild steel Tee sections, erected plumb, and securely fastened to the lift well framing by heavy steel brackets, suitably spaced, to limit deflection of guide rails to 3 mm under normal working conditions.

ii. The guide-rails shall be of suitable section with ends tongued and grooved, forming matched joint and shall be connected with steel fish plates.

iii. Guide-rails shall cover the full height of the hoistway and pit, such that it shall be not be possible for any of the car or counter weights shoes to run off the guides.

iv. Guides shall be designed to withstand the action of safety gear when stopping a counter weight or fully loaded car.

v. The max. deviation from true plumb and alignment of guide rails shall be 2 mm.

vi. All support framing shall be rigid and shall be designed to restrict displacement of the point of support of brackets to 3 mm under normal working conditions.

vii. The whole guide rail installation, including expansion joints, shall be designed for a smooth ride.

viii. The guide-rails shall be protected during storage and installation with a rust inhibiting coating which shall be cleaned off on completion of installation.

ix. Guide-shoes shall be adjustable type & mounted so as to provide continuous contact with guide rails under all conditions.
Guide shoes shall be provided at top and bottom of each side of car and counterweight and shall be designed for quiet operation.

Additional guide shoes shall be provided on each side of buffer frame in case of oil buffers.

Each lift shall be equipped with roller guides for up and down travel. There shall not be any metal-to-metal contact between Car and rail. Roller shall be mounted on ball bearings to provide quiet operation and excellent ride quality. (It is not required in case the design varies however the ride quality shall not be compromised for any other design).

11.0 SAFETY

In addition to other specifications, the lift shall be provided with safety devices as follows :-

i. Against overload

ii. Safety gear on car so that in the event of rope breaking or loosening, the car will be brought to rest immediately by means of grips on the guides.

The overspeeding car shall be automatically brought to a gradual stop on guide rails and power supply to the hoist motor shall be switched off.

iii. Overspeed centrifugal governor operating the safety gear in case of overspeeding of car in the down direction.

iv. Car gate lock so that in the event of car gate being opened when passengers are in the car, the lift will be brought to rest.

v. Overtravel limit switches at top and bottom limits of travel to disconnect the power supply and apply brakes to stop the car within a defined safe distance in case of overtravel in either direction

vi. Ultimate terminal switches to stop the car automatically within top & bottom clearances independently of normal overtravel limit switches but with buffers operative.

vii. Protective guards to counterweights in pit, rope sheaves and wherever required.

viii. Toe guard apron to the car platform.

12.0 CAR

a. Cabin Size

The internal clear dimensions of the cabin shall not be less than those specified in IS 14665-Part I, NBC2016 & CPWD General specifications for electric work (Lifts). The car shall be so mounted on the frame that vibration and noise transmitted to the passengers inside is minimised.
b. Frame and Safety Device

The car frame shall consist of mild steel channel/structural steel top and bottom securely riveted or bolted and substantially reinforced and braced so as to relieve the car enclosure of all strains when the safety device comes into action due to overspeed or when the capacity loaded car is run on the buffer springs at normal speed.

The safety device mounted on the bottom members of the frame operated by a centrifugal speed governor shall be arranged to bring the car to a gradual stop on the guide rails in the event of excessive descending speed; and provision shall be made to shut off the power supply to the motor.

c. Buffers

Substantial spring buffers (2 Nos.) shall be furnished and installed in the pit under the car and counterweight. These buffers shall be mounted on RCC Pedestals in the pit. The car buffer spring must be of correct design to sustain the car with capacity load without damage should the car terminal limits become inoperative. The car buffers must be located symmetricaly with reference to centre of car.

The Contractor may alternatively offer oil type buffers. The plunger shall be mild steel, designed for a very high factor of safety and accurately machined. A toughened rubber bumper shall be fitted to the plunger top to cushion the impact of steel buffer plates attached under the car and the counterweight. An oil gauge shall be provided to check the oil level.

d. Counterweight

The lift shall be suitably counter-balanced for smooth and economical operation. Cast iron weights shall be contained in a structural steel frame properly guided with suitable guide shoes (minimum 4 Nos). It shall be equal to the total weight of lift plus approx. 50% of the contract load.

Substantial expanded metal counter-weight screen guard shall be furnished and installed at the bottom of hoist way, as required by Lift Inspector.

e. Hoisting and Governor Ropes

Bright steel wire ropes with fibre cores suitable for Lift duty as per BIS Code shall be used for hoisting ropes.

Not less than 3 independent suspension ropes shall be provided and designed to share load equally by means of adjustable shackle rods with equalizer springs at each end of hoisting ropes.

Each rope shall have adequate section to provide a minimum factor of safety of 4 based on the max. force on the rope.

Governor ropes shall be similar to hoisting ropes. Their ends shall be securely attached to the car and to the safety gear. The governor ropes shall be tensioned by a weight loaded device in the pit.
The contractor shall submit the technical details and source of supply of ropes to the EPI as well as a certificate of performance of ropes from an approved test laboratory or Authority.

Compensation for travel shall be provided for all lifts having a travel of more than 30m.

f. **Enclosure**

The car enclosure shall be as specified in technical data sheet. The cabin floor, roof and walls shall be free of distortion and undue deflection as per IS 14665 – Part 4, Section 3.

g. **Brakes**

D.C. brakes will be spring-applied and electrically released. They shall be designed to provide smooth stops under variable loads.

h. **Doors**

Provision shall be made for vertical and horizontal fine adjustment of doors as per the specifications given in technical data sheet.

i. **Door Operators**

The door operators shall be VVVF inverter controlled heavy duty A. C. motor, allowing variable opening and closing speeds, and full synchronization of car and landing doors.

j. **Travelling Cables**

The traveling cables shall be multi-core with high conductivity stranded conductors specifically designed for lift duty. The cables shall be provided with retaining straps and individual cable clamps.

k. **Emergency Lighting**

A self-contained, non-maintained emergency light with a trickle boost charger shall be provided.

l. **Intercom**

An Intercom system shall be provided between the car, main landing, machine room and Fire Console room linked to EPABX located at Admn. Bldg.

m. **Manual Cranking Facility**

Manual cranking facility shall be provided in the machine room to facilitate evacuation of passengers in case of power failure. The manual mode shall be in addition to automatic car failure operation specified elsewhere.

n. **Emergency Stop Switch**

A stop switch in the machine room / top of car shall be provided for use by maintenance crew to cancel all car and landing calls for a particular lift.
o. Maintenance Switch

On operation of the maintenance switch located on top of the car by the maintenance crew, the car shall travel at slow speed not exceeding 0.85 m/sec by continuous operation of a button.

p. Landing Door Interlocks

Electrical interlocks shall be provided to ensure that the car does not operate unless all doors are closed and unless the car reaches a landing zone.

q. Overload Indicator (Only in Passenger elevator)

An overload indicator with buzzer shall be provided in the cabin to indicate to the passengers that the car will not start as it is overloaded.

r. Other Features

All features specified in the BIS/NBC/CPWD and in the enclosed technical specifications shall be provided.

s. Lift for Disabled

All the Passengers lifts shall be suitable for use by disabled persons. The following additional facilities shall be provided in this lift:

i. Full length handrails shall be provided on the rear and side wall panels.

ii. The door closing time shall be set for min. 5 seconds and the door closing speed shall not exceed 0.25 m/sec.

iii. The “door open” and “door closed” announcements shall be audibly made in the car.

iv. Braille signs / buttons.

t. Operating Panels, Buttons & Switches

Main and secondary car operating panels, buttons and switches shall be located on one of the two front wall panels next to the car door and as specified in the Schedule of lifts & as per approved G.A. drawings.

All buttons and switches shall be clearly legible with fade-proof text and figures, and shall be easily accessible, (especially for disabled persons in the lift designated for them).

13.0 ELECTRIC WIRING

Necessary insulated wiring to connect all parts of the equipment shall be furnished and installed. Insulated wiring shall be flame retardant and moisture resistant and shall be run in G.S. conduits. All cables shall be flame – retardant with copper conductors.
Trailing cables shall be PVC sheathed copper conductor multi-core ribbon type designed for lift service and shall be flame retardant and moisture resistant. They shall be flexible and shall be suitably suspended to relieve strains on individual conductors. All copper conductors shall be of appropriate gauge copper to avoid excessive voltage drop. All wires, cables, conduits, metal boxes, fittings and earthing shall comply with statutory requirements and BIS specifications.

The controller unit comprising of the MCCB, 25KA, adjustable overload and phase reversal and phase failure protection, all the circuit elements, transformer, rectifier for D.C. control supply, inverter power pack, terminal blocks etc. shall be enclosed in an insect vermin proof, sheet steel floor or wall mounted cabinet with hinged doors at front or at both front and rear. Proper warning boards and danger plates shall be provided on both sides of the controller casing. Sheet steel used for controller cabinet shall not be less than 14 gauge and shall be properly braced, where necessary. Suitable gland plate shall be provided for cable entry. The battery for the charger unit shall be suitably placed in the machine room. Degree of protection of Enclosure shall be IP54. Enclosure shall have provision of earthing studs.

All sheet steel work shall be painted with two coats of synthetic enamel paint of suitable shade both inside and outside over two coats of zinc primer.

Apart from lift controller enclosure, 7 distribution boards (3 Main DB + 4 DB) are required as per BOQ. Cables to incomer of these DB’s shall be terminated by others, whereas outgoing cables for lift shall be in the scope of lift contractor. Contractor shall furnish the sizes of cables along with KW rating of motors.

14.0 **PAINTING**

All exposed metal work furnished in these specifications, except as otherwise specified, shall be given one shop coat of anti-corrosive primer after approved surface treatment of metal surfaces and two coats of approved enamel paint of approved shade. After installation of Lifts, a final Touch-up Coat of paint shall be applied.

15.0 **WORKS TESTS**

The following tests shall be carried out at Works. EPI shall be given notice of the time and procedure of the tests before they are carried out, and shall be given facilities for observing the tests at Works.

a. High voltage works tests of equipment which is not already tested in accordance with appropriate IS codes.

b. Buffer test.

16.0 **TESTS ON COMPLETION**

The following tests shall be carried out to the satisfaction of the EPIL / STPI.

i. Insulation resistance and earth test for all electrical apparatus.

ii. Continuous operation of the lift under full load conditions and simulated starts and stops (150 nos. per hour each) for one hour at the end of which time the service temperature of the motor and the operating coils shall be tested. This shall be as per B.I.S. specification.
iii. The car shall be loaded until the weight on the rope is twice the combined weight of the car and the specified load. The load must be carried on for about 30 minutes, without any sign of weakness, temporary set or permanent elongation of the suspension rope strands.

iv. The following items shall be tested:

a. Leveling accuracy at each landing in conditions of fully loaded and empty car.
b. No load current and voltage readings both on ‘Up’ and ‘Down’ Circuits.
c. Full load current and voltage readings both on ‘Up’ and ‘Down’ Circuits.
d. One and quarter load current and voltage readings both on ‘Up and ‘Down’ Circuits.
e. Stalling current and voltage and time taken to operate overload.
f. Overload protection.
g. Gate sequence relays, if provided and installed.
h. Car and landing door interlocks.
i. Collective control and priority sequences, if installed.
j. Safety gear mechanism for car and counterweight with fully loaded car and also with only 68 kg load.
k. Speeds on Up and Down travel with full load, half load and empty car.
l. Door contacts.
m. Final terminal stopping device.
n. Normal terminal stopping device.
o. Car and counterweight buffers with contract load and contract speed.
p. Operation of controllers.
q. Manual operation of lift at mid-way travel.
r. Emergency operation.

v. Tests on completion shall also be performed to the satisfaction of Inspector of Lifts and a certificate will be obtained from the ‘Lift Inspector’ by the contractor.

17.0 STATUTORY APPROVALS

All statutory approvals from commencement to commissioning of lifts shall be obtained by the Contractor from the Inspector of Lifts and / or other authorities. However, the client will provide all necessary assistance for providing documents, drawings and certificates pertaining to other contractors, if required.

The contractor shall pay necessary fees in connection with the approval of installation of lifts.

18.0 FEATURES REQUIRED FOR VVVF LIFTS

(a) Group / Independent / Attendant Operation

It shall be possible to group specified cars in a group wherever required with dynamic disposition of cars as required by the traffic pattern. A smart car dispatching system with ring communication shall be provided for optimum passenger comfort and lift performance under all traffic conditions. Any defective car shall be automatically eliminated from the group.
Each car shall be provided with a keyswitch for independent operation housed in a service cabinet. In this mode, the lift shall respond only to car calls. Hall calls will not be registered.

It should be possible for an attendant to operate any car.

(b) **Fireman’s Switch**

A fireman’s toggle switch shall be provided in a break glass for the specified lift at ground floor to enable firemen to bring the lift non-stop to ground floor from any location and to cancel hall calls until the car is operated on attendant control.

(c) **Emergency Power Operation**

In case of power failure, standby power equipment shall enable lifts to reach a pre-determined floor, in a pre-determined sequence, and then permit operation of one or more lifts on emergency power.

A trickling battery shall be provided to supply power to light fixtures, fan, alarm and intercom.

(d) **Profile Generator**

A profile generator or similar device shall be provided to use the car at an optimum speed level and to improve levelling accuracy.

(e) **Predictive Car Selection**

Once a hall call is registered, a dynamic car algorithm shall transfer the call to an optimally selected car to provide the maximum traffic efficiency.

(f) **Home Landing Facility**

A car shall return to a pre-determined landing after the last call is answered.

(g) **Door Safety**

Multi-beam infrared / ultrasonic electronics curtains shall be provided to scan the doorway and reverse the door closing in case of any obstruction.

(h) **Double Door Operation**

If both up and down calls are registered at a hall which is the last registering hall in the direction of the car, the lift shall travel to that hall and open / close the doors. After this, the car shall reverse its travel and shall open / close the doors again unless no car calls are registered at that floor.

(i) **Nudging Door Operation**

When the doors remain open for more than a predetermined period, a buzzer shall sound and the door shall close automatically. The door sensing device
shall be rendered inoperative but the Door Open button and the safety shoe shall remain operative

(j) **Selective floor Service**

Programming for selective floors services shall be software driven.

(k) **Manual Cranking & Slow speed Travel**

A manual cranking facility shall be provided.

Slow speed operation shall be possible from machine room and car top.

(l) **Auto Fan Off**

In case no calls are registered for a pre-set time, the cabin fan shall be automatically switched off.

(m) **Automatic Rescue Device**

In case of mains power failure and Lift control system failure, the Lift’s own rechargeable and maintenance free battery power shall move the car to the nearest floor and the door shall open automatically for automatic rescue of passengers. A battery run-down indicator shall be provided.

19.0 **PERFORMANCE PARAMETERS**

The following parameters shall be achieved in the installation :

* Levelling Accuracy \( \pm 3 \text{ mm for } 1.5 \text{ m/s speed} \)
* Jerk level \( 0.9 – 1.5 \text{ m/s}^3 \)
* Noise level in car \( 58 \text{ dB} \)
* Noise level at 1 M in machine room \( 60 \text{ dB} \)
* Acceleration rate \( 0.6 – 1.0 \text{ m/s}^2 \) (adjustable)
* Max. car vibration \( 20 \text{ milli gals.} \)

20.0 **SUBMITTALS ‘ALONGWITH TENDER’ AND ‘POST AWARD’**

(A) The following items are required to be submitted in duplicate **along with the Tender**.

i. Catalogues with offered items highlighted.
ii. List of imported components, if any.
iii. Compliance Statement for guaranteed performance parameters given in Specification 19.0 above.
iv. Confirmation that offer submitted meets the technical specifications & scope of work and there are no deviations and exclusions from NIT.
v. The contractor shall specify in his offer the full capability of his system in this regard.

(B) The successful contractor, **after award of the contract**, shall furnish following technical particulars of the equipment/devices for the approval by EPIL / STPI.

i) Single line/ schematic diagram of electronic control panel, lift & equipment etc.
ii) Layout of Hoistway, Lift machine room, showing foundation details in the pit, machine room, electric control panel, Lift & equipment etc.

iii) Earthing layout.

iv) Inspection manual for equipment & accessories covered in the scope of supply (8 copies).

v) Technical literature of operation, control and maintenance etc. (8 copies) alongwith CDS.

vi) Schedule of scope of maintenance service during defect liability period and AMC.

The technical parameters furnished by the tenderer would be examined in detail during design submission stage. All improvements considered necessary to meet the tender Technical Specifications would have to be incorporated without any additional cost to EPIL / STPI with objective of providing high performance and safety Lifts.

21.0. MAINTENANCE DURING DEFECTS LIABILITY PERIOD

Comprehensive maintenance during Defects Liability Period inclusive of periodic servicing, prompt attention to client (STPI) complaint, prompt rectification of all malfunctions and equipment failures, replacement of defective equipment / parts, replacement of light fittings, lubrication including lubricants, maintaining correct alignment and leveling of cars and ensuring smooth running, starts and stops etc. all complete to EPIL / STPI’s satisfaction shall be done.

22.0. ANNUAL MAINTENANCE (AMC) FOR FIVE YEARS AFTER ONE YEAR OF DEFECTS LIABILITY PERIOD

Comprehensive maintenance during AMC for 5(Five) years (after one year of defect liability period) inclusive of periodic servicing, prompt attention to client (STPI) complaint, prompt rectification of all malfunctions and equipment failures, replacement of defective equipment / parts, replacement of light fittings, lubrication including lubricants, maintaining correct alignment and levelling of cars and ensuring smooth running, starts and stops etc. all complete to STPI’s satisfaction shall be done. For every 1(one) hour of delay in attending for a fault after allowing for 4 (four) hours from the time a complaint has been lodged, will attract penalty at the rate of Rs.150/- per hour.
CONSTRUCTION OF INCUBATION CENTRE FOR SOFTWARE TECHNOLOGY PARK OF INDIA (STPI)

AT

PLOT NO. 4&5, SECTOR-7, GIDA, GORAKHPUR

VOLUME – 2, Part – V
(Access Control & CCTV System)
STANDARDS & REGELATIONS:

- **NFPA-72**: National fire protection academy code for fire alarm & public address system
- **NFPA-72**: National fire protection academy code for fire alarm & public address system
- **IS-2189**: Selection, Installation & Maintenance of Fire Detection and Alarm System.
- **NFPA 70**: National Electric Code UL: Underwriters Laboratories, Inc. (UL) Publication-2775
- **IS-694**: Specification for PVC insulated cables for working voltages up to and including 1100V
- **IS-9968 (Pt-1)**: Rubber Insulated Braided Wire
- **IS-1554 (Pt-1)**: PVC Insulated Cables
- **EN 50130-4:1995**: To ensure the protection of people and, property in the form of an intruder alarm system, hold-up alarm system, CCTV systems, access control systems or social alarm systems. In terms of electromagnetic compatibility is necessary to address issues of the conformity assessment of products, selection of suitable components and in particular method of installation in a specific area of deployment.
- **BS 5887:1980**: Code of practice for testing of computer based Systems
- **BS 4808**: Specification for low frequency cables and wire for Telecommunication
- **BS 6558**: Optical fibres and cables
- **IEC65-WG9 65A**: Software for computers in the application of industrial safety related Functional safety of programmable electronic systems:
- **IEC65-WG10**: Generic aspects 65A (Secretariat)
- **IEEE802.3**: CSMA/CD Local Area Network Protocol
- **IEEE 802.4**: Token Bus Local Area Network Protocol
- **IEEE 802.5**: Token Ring Local Area Network Protocol
- **ISO 9000-3**: Guidelines for the application of ISO 9001 to development, supply and maintenance of software.
- **ASTM B 3-90**: Soft or Annealed Copper Wire.
- **ASTM 4565**: Cold Bend Test.
- **ASTM 4565**: Physical and Environmental Properties of Insulation and Jackets for Telecommunications Wire and Cable.
- **ANSI/ICEA S-90-661**: Individually Unshielded Twisted Pair Indoor Cables.
- Category 3, 5, 5e & 6: For Use in General Purpose and LAN Communications.
- **ANSI/TIA/EIA568B.2**: Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted Pair Cabling Components Addendum 1 Category 6
1.0 IP BASED CLOSED CIRCUIT TELEVISION SYSTEM

1.1 CCTV system shall be provided for obtaining live view of the authorized / unauthorized entry, unauthorized intrusion, abnormal conditions in process areas and recording the events for future investigation.

- CCTV system shall be integrated into IBMS for escalation of violations in security protocols and unauthorized intrusion into the facility. The integration shall be carried out at higher level without use of dry contact/physical wired connections between the systems.
- The high level interfaces shall be MODBUS interface to facilitate higher number of alarms being passed between the systems using data interface. The data interfaces shall be based on industry standard open standard protocols. **Details of such protocols from all the manufacturers shall be declared to STPI for future development.**
- In addition the above systems shall also be integrated to Process Control Systems (PCS) using MODBUS protocol for exchange of data between the systems.

1.2 CCTV SYSTEM - Functional Requirements

1.2.1 The CCTV system shall be used to monitor the perimeter for unauthorized entry into the premises and associated facilities by breaching the perimeter of the building and common areas.

- Monitor and record personnel and vehicles entering the facility with high resolution.
- Monitor common areas for safety of personnel and critical equipment like DG, UPS etc

1.2.2 The CCTV System shall be an integrated system for the building with IP based camera and centralized server with storage. The system shall be supplied and installed based on PAL standard.

1.2.3 CCTV system shall comprise of

- a. Outdoor Weather Proof PTZ Cameras
- b. Dome/Bullet IR Colour Camera
- c. Min 3Megapixel Cameras
- d. Optical Transceivers
- e. Matrix Switcher
- f. Multiplexers (Video Quad)
- g. Keyboard
- h. IP Video Encoders
i. Network Storage Unit
j. Video Management System
k. Server
l. Ethernet Switches
m. OPC/Gateway
n. Monitors

1.2.4 Looped Videos of selected security related cameras shall be extended to a video multiplexer (QUAD).

1.2.5 Spot output of the Quad shall be connected to one of the matrix switcher inputs. Security personnel shall be able to view video from multiple cameras on a single screen or multiple screens in IBMS Room.

1.2.6 All the IP Cameras shall be connected an Ethernet switch. Video compression shall be based on H.264.

1.2.7 A separate local area network with dedicated Ethernet switches shall be implemented to create a new domain for CCTV, Access Control System and IBMS System. The new domain shall be termed as IBMS Domain. Megapixel shall be connected to the IBMS domain Ethernet switches directly.

1.2.8 Video Encoders shall send two streams of video in to the network. One of the streams shall be used for live view and the second stream is sent to the network video recorder for storage. Encoder’s shall be intelligent type with motion detection feature for alerting in case of movement or change in the area being viewed.

1.2.9 It shall be possible to configure at least three zones on the area being viewed by the camera. The size of the zones shall be configurable. Encoders shall also provide facility to initiate an alarm using motion detection in any single zone or a combination of any two or three zones.

1.2.10 Network Video Storage unit shall be sized to retain 30 days of video from all the cameras. The archive video shall be stored with 12fps (frames per second) for normal conditions and 25fps for alarm conditions.

1.2.11 Pre alarm and post alarm video shall also be stored at 25fps. The pre alarm and post alarm period shall be programmable in the CCTV System.

1.2.12 Video Management Server shall manage all the IP encoders, Network storage units and the client workstations for remote management, authentication of clients, moving of cameras based on alarms from various systems according to the Preset positions. Video management server and Network Storage Unit Make and configuration shall be according to the CCTV system manufacturer recommendations.

1.2.13 CCTV central equipment shall be installed at the IBMS Room at Block E. Contractor shall provide and install the servers and engineering workstations located in the CCTV central equipment cabinets. Remote viewing of archive video and live video from the IP cameras shall be possible at the following locations.
   • IBMS Room
   • Authorized personal at client side like FMS team
1.2.14 Building indoors shall be provided with Indoor IP bullet min 3 Megapixel cameras to monitor the common area’s movement like lift lobby.

1.2.15 Min 3 Megapixel cameras shall be installed at the entry gates to monitor personnel and vehicles entering the facility. This is in order to clearly identify personnel and vehicle numbers, vehicle types in case of incident investigation. Two cameras shall be positioned at different heights to view inside of Trucks and Cars driver’s cabin.

1.2.16 All Outdoor cameras Maximum coverage shall be achieved by positioning of cameras in optimised locations. Position of cameras shall be closely coordinated with the operations team and security team during the execution stage of the project.

1.2.17 Megapixel cameras shall be connected via CAT6 cables to the IBMS Domain Ethernet Switch.

1.2.18 To ensure stability in the picture all outdoor cameras shall be installed on wall using with mounting bracket to a maximum possible extent or else mounting GI poles.

1.2.19 Perimeter Security cameras shall be mounted on the boundary wall. Boundary wall shall have reinforced concrete columns for installation of cameras.

1.2.20 The IP Based Video Management System shall provide an open standard interface for high level integration with Access Control and IBMS system for moving cameras to preset positions in case of an alarm or an event.

1.2.21 IBMS Room shall be provided with 36” High definition LED monitors mounted on wall for viewing of video and Client Workstation.

2.0 TECHNICAL REQUIREMENTS

2.1 PTZ OUTDOOR CAMERAS

2.1.1 Camera shall be high resolution 1/3” CCD colour cameras. PTZ cameras shall be provided with facilities that include pan, tilt and motorized zoom lens.

2.1.2 Contractor shall submit the calculation the lens and focal length requirements to meet the coverage required during the execution. However the motorized zoom lens shall offer a minimum 20:1 zoom ratio, continuously variable between 10mm (wide angle) and 200mm (telephoto) as minimum. The camera shall have auto focus and auto iris features.

2.1.3 Pan rotation shall be 360 Deg continuous endless panning and tilt rotation shall be at least +/-90 Deg from Horizontal position. The camera shall support Variable high speed Pan and Tilt functions such that the target can be spotted and focused instantaneously when a preset function is triggered or when the operator is moving the camera.

2.1.4 Programmable pre-set positions for pan, tilt and zoom shall be available that allows the operation of a surveillance ‘tour’ of each similarly equipped camera. The camera shall support a minimum of 125 preset positions and
6 tours. The preset positions shall include Pan, Tilt, Zoom with Auto focus and Auto Iris. Clear picture shall be visible on the screen immediately after triggering a preset position.

2.1.5 The cameras shall be installed in an environmental housing to meet the area certification and equipped with wind screen, demister, sun shield and wipe.

2.1.6 Cameras shall be of Day/Night Wide Dynamic Range type and shall operate satisfactorily at light levels above 0.05lux. In the event of light levels being lower than that able to support colour reproduction, the camera shall be capable of automatically switching from colour to monochrome operation that enables the camera to operate at light levels of 0.001lux. The cameras shall be fitted with an auto-iris function to compensate for vary in light level conditions.

2.1.7 Cameras shall be installed at suitable position in alignment with the lights such that a clear view is obtained on the monitor.

2.2 MEGAPIXEL BULLETCAMERAS

2.2.1 Megapixel fixed cameras shall be used at the security gates, Common areas and IBMS room for monitoring and high resolution recording of personnel and vehicles entering the facility. The cameras shall be positioned properly to identify personnel and vehicle number plates by zooming into the picture for investigation in future.

2.2.2 The cameras shall provide a minimum of 3 Megapixel resolutions with 25fps. The camera shall support various resolution settings in the configuration.

2.2.3 The cameras shall be powered from the IBMS domain Ethernet Switch using Power over Ethernet (POE). External Power supply shall not be used. The camera shall support H.264 standard. It shall provide a minimum of two video streams with one fixed high resolution for recording and second with configurable resolution for live viewing of video.

2.2.4 Manual Pan Rotation shall be +/- 180 Deg continuous and Manual tilt rotation shall be at least +/- 90Deg with camera looking down.

2.2.5 Contractor shall submit their calculation the lens and focal length requirements to meet the coverage required and determine the black spot.

2.2.6 Cameras shall be of IR LED type @ 30 mts and shall operate satisfactorily at light levels above 0.5lux. In the event of light levels being lower than that able to support colour reproduction, the camera shall be capable of automatically switching from colour to monochrome operation that enables
the camera to operate at light levels of 0.03lux. The cameras shall be fitted with an autoiris function to compensate for varying light level conditions.

2.2.7 Cameras shall be installed at suitable position in alignment with the lights such that a clear view is obtained on the monitor.

2.3 NETWORK STORAGE UNIT

2.3.1 Network storage unit shall be connected to the IBMS domain Ethernet switch using 10/100/1000Base Ethernet interface.

2.3.2 The storage unit shall be sized to accommodate continuous video storage for 30 days as per the requirements be low or 52TB (Tera Bytes) whichever is higher.

2.3.3 12fps for normal video 25 fps for alarm video with configurable prealarm and post alarm video duration. The system shall record a minimum of 15 minutes pre alarm and 15 minutes of post alarm video storage at 25fps.

2.3.4 Alarm duration shall be 1 hour per day per camera for storage sizing purposes. The storage unit shall be provided with RAID 6 storage data protection against hard disk failure. The hard disks shall be hot swappable.

2.3.5 The system shall have built in automatic defragmentation routines to avoid data getting fragmented.

2.3.6 The system shall record H.264 Compressed video from Cameras.

2.3.7 The storage unit shall have redundant hot swappable power supply and fan units. The storage unit shall support tagging of video.

2.3.8 The network storage unit shall support a recording through put of 165Mbps to 330 Mbps of read through put at all times. There shall be no limitation on the number of cameras being used with the storage unit for recording or reading activity.

2.3.9 The network storage unit shall be fully manageable using the Ethernet interface.

2.4 VIDEO MANAGEMENT SYSTEM SERVER

2.4.1 The Video Management System server shall be an integrated system that manages all the CCTV system components IP cameras, Network Storage Unit. It shall
- Act as a Dynamic Host Configuration Protocol - DHCP server allocating IP address to all the CCTV Equipment
- Hold configuration data base of the systems.
• Provide authentication, control and facilitate interaction between all the devices within the CCTV network.
• Act as an NTP server for service date and time to various system components. Shall be capable of synchronising with external high accuracy time source.
• Shall manage security for all devices, clients, login, passwords, user groups, user privileges,
• Maintain a data base of device related alarms and associated videos for easy access in future.
• Maintain fault logs for various faults within the system.
• Manage storage unit of the CCTV system.

2.5 CLIENT AND ENGINEERING WORK STATIONS

2.5.1 The work station shall work as a HMI (Human Machine Interface) for the Video Management System. The system shall

• Provide live and archive viewing of video from all the cameras.
• Provide full access to all the IP cameras including PTZ Control, Iris and Focus control, Camera configuration, Preset configuration and Preset positioning etc.
• Have facility to load MAPs of the sites in various file formats including GIF, TIF, BMP, JPEG and other Provided facility to have interleaved maps with embedded icons / hyperlinks to camera and alarm device icons with expanded view of a part of the facility.
• Provide interactive configurable icons with facility to associate them with devices. The icons shall support controlling of devices, know device status including alarms.
• Support dual monitors. In general one of the monitors shall be used for MAP and Icons view and the second monitor for viewing of video from various sources.
• Facilitate writing of scripts and associating the scripts with alarms, icons and various devices.
• Act as virtual matrix and support mapping of video from any source to any monitor.
• Act as a virtual multiplexer (QUAD) and support viewing of up to 16 cameras in a single screen simultaneously.
• Support time synchronised play of stored archive video of up to 16 cameras. Simultaneous viewing of standard resolution and megapixel cameras must be possible on the same display.
• Support exporting of snap shots, video in various file formats including AVI, BMP and JPG. The exported video shall be stored in transportable storage devices like CD/ DVDROM, USB etc.
• Provide extensive alarm handling features including provision of help text for showing the handling procedure for the specific alarm, write notes and feedback while activating or acknowledging the alarms.
• Provide the ability to control and program any camera equipped with PTZ.
2.5.2 The workstation shall be capable of the following operations
- Manually control the PTZ
- Set the pan/tilt home positions from annual or alarm activation
- Automatically control the cameras through an alarm trigger
- Ability to set multiple preset positions
- Ability to set multiple tours
- Remotely set and clear the movement limits of the pan/tilt mechanism from the control room, through a telemetry unit at an outdoor camera site
- Adjust the zoom lens graphics file formats.
- Ability to control the camera menu and setup the camera through the IP video security system

2.5.3 The workstations shall be provided with two 21” High Definition LCD colour monitors with DVI interface for view of standard resolution and megapixel cameras. Client work station shall only have privileges to use the system. Engineering workstations shall be provided with privileges to modify configuration of the entire CCTV system and associated components.

2.5.4 It shall be possible to select any monitor to display live full screen single, sequential or multiple pictures from any combination of cameras selected from the operator work station keyboard.

2.6 ETHERNET SWITCHES

2.6.1 Ethernet switches shall be minimum of 24 ports x 100 Base T and 4 x 1000 Base uplink interfaces.

2.6.2 Suitable optical interface modules shall be provided for interconnecting switches at various locations.

2.6.3 Connectivity to network storage unit and Client workstation shall be 1000 Base T.

2.6.4 Cameras and video encoders shall be connected to the switches using 100 Base T ports.

2.7 GATEWAY

2.7.1 CCTV system shall be equipped with an Open Process Control or a Gateway device which can exchange data between CCTV system Access Control System and Perimeter Intrusion Detection system for meaningful integration of the three systems.

2.7.2 The integration shall facilitate automated response of various security systems to unauthorised intrusion alarms and escalation of alarms to Security personnel for further action.
2.7.3 Integration shall beat a higher level using data interfaces, various protocols and exchange of data between systems. Use of dry contacts for communicating alarms between systems is not acceptable.

2.8 NETWORK PoE SWITCH (10/100Mbps):

The network should have following features and specifications

**FEATURES:**

2.8.1 IEEE802.3af Power over Ethernet (PoE) standard compliant (DTE power via MDI)

2.8.2 Complies with IEEE802.3 and IEEE802.3u standards

2.8.3 24 x RJ-45 10/100Mbps auto speed switch ports

2.8.4 Built-in 4 x PoE ports with maximum 15.4W per port

2.8.5 Supports PoE Power Device (PD) classification identify

2.8.6 Provides over current and circuit shorting protection

2.8.7 Supports N Way protocol for speed (10/100Mbps) and duplex mode (Half/Full) detection

2.8.8 All ports with auto MDI-X function for switch-to-station & switch-to-switch connection with non-cross over cable

2.8.9 Supports full and half duplex operation on all ports

2.8.10 Operates at max. packet filtering and forwarding rate

2.8.11 Store and forward transmission method

2.8.12 Easy-to-read LEDs provide instant operating feedback

2.8.13 Supports 1K MAC address entries in whole system

2.8.14 768K bits buffer memory

2.8.15 Desktop size with 19” rack mountable bracket

2.8.16 Convenient internal switching power, 100 ~ 240V AC
1.0 ACCESS CONTROL SYSTEM (ACS):
The Access control system shall have been covered the IBMS Room and Security Main Entrance with Smart cards system for the commercial.

Areas to be covered:

- Entries to all blocks
- Vehicle - Entry and Exit @ Main gate (Boom Barriers)
- Pedestrian - Entry and Exit

1.1 ACCESS CONTROLLER-MODULAR TYPE

General Specification

1.1.1 The Access Card Controller shall be of modular design with a download software built-in so that the application program can be easily changed and downloaded without the physically touching the controller itself.

1.1.2 The connection from the Access Card Controller to the Access Card system server running the management software shall preferably by Ethernet 10/100/1000 Base T or RS-485.

1.1.3 The Access Card Controller shall have a 16-characters liquid crystal display (LCD), and a button provided for selective display to show all its network parameters and actual status like:
   a. IP address of the controller
   b. MAC address of the controller
   c. DHCP on/off
   d. Status of all the inputs connected to it
   e. Status of all the outputs connected to it
   f. Online and Offline status of the controller
   g. Firmware version
   h. Date and Time – A real time clock (RTC) that will adjust itself to leap year computations automatically.

1.1.4 The Access Card Controller shall support and include a standard Compact Flash (CF) memory card for storing cardholder data and access events. The CF memory card must be formatted with a standard FAT file system, to allow reading them using a standard card reader connected to a computer, if the Access Card Controller fails.

1.1.5 The Access Card Controller memory shall under no circumstance lose a single, not even the last transaction when power fails.
1.1.6 The Access Card Controller and all devices connected to it shall continue to operate and control access in off-line mode, even if the computer network fails.

1.1.7 The Access Card Controller memory shall store database that has a capacity with a minimum of 80,000 cardholders (upgradeable to 400,000), each having a programmable 10 digits (personal Identification Number) PIN codes.

1.1.8 The cardholder database shall be upgradeable by exchanging the CF card. The system shall automatically detect the size of the CF-card.

1.1.9 The Access Card Controller provided shall support the connectivity of up to 4 standard Wiegand interface readers or up to serial interface readers operating on RS 485 bus technology.

1.1.10 The Access Card Controller shall provide minimum eight programmable I/Os on board, and shall be expandable to 56 each, using I/O extensions.

1.1.11 All inputs provided shall be configurable to provide 2- or 4- status selectable, via End-Of-line (EOL) resistors, namely:
   a. Input Closed
   b. Input Opened
   c. Input Shorted (provided in 4- status mode)
   d. Input Tamper (Cable cut, provided in 4- status mode)

1.1.12 EOL resistor's values shall be flexible selectable in the Access Control System management software during configuration.

1.1.13 UPS shall be provided to continually supply power to the Access Card Controller and readers for a minimum of 2-hours, in the event of power failure subject to retrieve the power.

1.1.14 The Access Card Controller shall generate a transaction record and save them in the memory for every alarm, they include:
   a. Time/date of occurrence and restoration.
   b. Location of alarm sensors.
   c. Surveillance of Employees/Regular Visitors/Casual Visitors: All personnel visiting the buildings may be divided into three categories i.e. Employees, Regular Visitors (who are issued passes for specific period of not more than 03 months) and Casual Visitors (who are issued passes for the day). The system should be capable of the following:
      o Provision of unique Access Card having smart card technology.
      o Read facility.
      o Surveillance and recording of entry and exit of personnel through dedicated access doors.
      o Restricting access of visitors to specific office by creating electronic barriers.
- Detection of a visitor who doesn’t meet designated officer or doesn’t report back at reception/exit gate after meeting the officer in the given time frame.
- Signage System within the building for Zone indication and evacuation.
- A Central Video Display Unit and integrated public address system for parking areas and building under the control of IBMS room or designated person on a single platform.
- The Platform should provide for the flexibility of sending alert message/announcement to particular individual/zone/entire buildings.
- Power back up and inbuilt redundancy for each hardware. Provision for this feature may be in-built in the system.
- Integration of Pass Section – security cabin, Reception Offices and Main security officer: System Architecture should cater for integration of Pass Section, Reception Offices and the Central Control Unit for effective Pass and Vehicle management.
- The ACCESS CONTROL SYSTEM shall be so designed that any failure of any sub-system shall not affect the normal operation of another sub-system; they shall continue to operate normally in a non-degraded mode.
- The System Integrator/Firm submitting the Access control system Application Software proposed for the project shall show proven operational record of such nature in their bid documents.
- The Access control software with GUI shall be capable to integrate with Facility management software, visitor’s management system, Time and attendance software etc (which is part of package).
- The Software licensee will be multiuser package (N+2) with min capacity of 50000 card holders.

1.2 SMART CARD READER:
General Specification

1.2.1 The Smart Card Reader shall be of ruggedized design, having weatherized polycarbonate enclosure or similar protection to withstand harsh environments for both indoor/outdoor used and provides a high degree of vandal resistance.

1.2.2 The Smart Card Reader shall provide two-factor authentication with the combination of a proximity [contactless smart] Card

1.2.3 The Smart Card Reader together with the contactless smart card shall support operation with 1:1 verification mode identification mode.
1.2.4 The Smart Card Reader shall continue to operate to control access in off-line mode. When the network connection restored, the reader shall automatically upload and synchronize its database with the server.

1.2.5 The Smart Card Reader provided shall have a read tolerance of at least ±30 degree.

1.2.6 The same Smart Card Reader provided shall be able to be used for both access control and as an enrolment station.

1.2.7 The Contractor shall supply and install the software provided shall be integrated to the SACMS for access control and monitoring.

1.2.8 The card reader shall be based on contactless smart card 13.56MHz technology for connection to the AMC with Wiegand interface.

1.2.9 The card reader provided shall be capable of reading CSN number in 32-bit format in accordance with ISO standard 14443 Series.

1.2.10 The data transfer between the contactless smart card reader and smart card shall be encrypted.

1.2.11 Power requirement: 10 – 16Vdc.

1.2.12 The card reader shall have a read range of at least 3”.

1.2.13 The response time to unlock the door after a card is presented to the card reader shall not exceed 1.0 second ± 0.5 second.

1.2.14 The card reader unit shall have an integral keypad with beeper, multi-colour LEDs.

1.2.15 The keypad shall have back-light to allow easy viewing, in case of power blackout. It shall lights automatically upon pressing any key or when a card is presented to the reader.

1.2.16 The overall thickness of the card reader unit shall not exceed 30mm.

1.2.17 Certification: CE and UL Listed.

1.3 BOOM BARRIER
General Specification

1.3.1 The Boom Barrier shall consist of a retractable Boom, single phase torque motor with weather proof housing, control for both manual & automatic operation.
1.3.2 The motor shall be a maintenance free direct drive torque motor to enable a harmonious smooth movement of Boom without bouncing and there should not be a need for a counter balance springs. The Boom Barrier shall be capable of locking in full open & close positions. Motor operating capacity will be minimum 15 years of life as per standards.

1.3.3 However, in case of power failure the boom barrier shall be capable of operating manually and without using any tools. In an event of Power failure, the Barrier shall open automatically and shall close be closed either through a manual reset or through an external signal.

1.3.4 The Boom shall be extruded from highly stable Aluminium alloy with an octagonal profile and shall be finished with a RAL 9010 / Client /consultant approved powder coat with a bright red reflective tape stripes for better night visibility.

1.3.5 The Boom Barrier shall be operated on 230V single phase power source. The opening & closing time shall not exceed 5 seconds each.

1.3.6 The high read range smart card reader shall be kept on either side of the boom barrier for entry / exit management of cars/ two wheelers in the premises which is mentioned in concept entry.

1.3.7 The length of the barrier will be given as per specified line item in tender.
CONSTRUCTION OF INCUBATION CENTRE FOR SOFTWARE TECHNOLOGY PARK OF INDIA (STPI)

AT

PLOT NO. 4&5, SECTOR-7, GIDA, GORAKHPUR

VOLUMN – 2, Part - IV
(PV ENERGY SYSTEM)
DEFINITION

A Grid Tied Solar Rooftop Photo Voltaic (SPV) power plant consists of SPV array, Module Mounting Structure, Power Conditioning Unit (PCU) consisting of Maximum Power Point Tracker (MPPT), Inverter, and Controls & Protections, interconnect cables and switches. PV Array is mounted on a suitable structure. Grid tied SPV system is without battery and should be designed with necessary features to supplement the grid power during day time. Components and parts used in the SPV power plants including the PV modules, metallic structures, cables, junction box, switches, PCUs etc., should conform to the BIS or IEC or international specifications, wherever such specifications are available and applicable.

Solar PV system shall consist of following equipment / components.

- Solar PV modules consisting of required number of Crystalline PV modules.
- Grid interactive Power Conditioning Unit with Remote Monitoring System
- Mounting structures
- Junction Boxes.
- Earthing and lightening protections.
- IR/UV protected PVC Cables, pipes and accessories

SOLAR PHOTOVOLTAIC MODULES:

The PV modules used should be made in India. The PV modules used must qualify to the latest edition of IEC PV module qualification test or equivalent BIS standards Crystalline Silicon Solar Cell Modules IEC 61215/IS14286. In addition, the modules must conform to IEC 61730 Part-2 – requirements for construction & Part 2 – requirements for testing, for safety qualification or equivalent IS.

a) For the PV modules to be used in a highly corrosive atmosphere throughout their lifetime, they must qualify to IEC 61701/IS 61701

b) The total solar PV array capacity should not be less than allocated capacity (kWp) and should comprise of solar crystalline modules of minimum 250 Wp and above wattage. Module capacity less than minimum 250 watts should not be accepted

c) Protective devices against surges at the PV module shall be provided. Low voltage drop bypass diodes shall be provided.

d) PV modules must be tested and approved by one of the IEC authorized test centers.

e) The module frame shall be made of corrosion resistant materials, preferably having anodized aluminum.
f) The bidder shall carefully design & accommodate requisite numbers of the modules to achieve the rated power in his bid. [NAME OF THE ORGANISATION]/owners shall allow only minor changes at the time of execution.

g) Other general requirement for the PV modules and subsystems shall be the Following:
   I. The rated output power of any supplied module shall have tolerance of +/- 3%.
   II. The peak-power point voltage and the peak-power point current of any supplied module and/or any module string (series connected modules) shall not vary by more than 2 (two) per cent from the respective arithmetic means for all modules and/or for all module strings, as the case may be.
   III. The module shall be provided with a junction box with either provision of external screw terminal connection or sealed type and with arrangement for provision of by-pass diode. The box shall have hinged, weather proof lid with captive screws and cable gland entry points or may be of sealed type and IP-65 rated.
   IV. Curves at STC should be provided by bidder.

Modules deployed must use a RF identification tag. The following information must be mentioned in the RFID used on each modules (This can be inside or outside the laminate, but must be able to withstand harsh environmental conditions).

   a) Name of the manufacturer of the PV module
   b) Name of the manufacturer of Solar Cells.
   c) Month & year of the manufacture (separate for solar cells and modules)
   d) Country of origin (separately for solar cells and module)
   e) I-V curve for the module Wattage, Im, Vm and FF for the module
   f) Unique Serial No and Model No of the module
   g) Date and year of obtaining IEC PV module qualification certificate.
   h) Name of the test lab issuing IEC certificate.
   i) Other relevant information on traceability of solar cells and module as per ISO 9001 and ISO 14001

14.1.4. **Warranties:**

   a) Material Warranty:

      i. Material Warranty is defined as: The manufacturer should warrant the Solar Module(s) to be free from the defects and/or failures specified below for a period not less than five (05) years from the date of sale to the original customer ("Customer")
      ii. Defects and/or failures due to manufacturing
      iii. Defects and/or failures due to quality of materials
iv. Non conformity to specifications due to faulty manufacturing and/or inspection processes. If the solar Module(s) fails to conform to this warranty, the manufacturer will repair or replace the solar module(s), at the Owners sole option.

b) Performance Warranty:

i. The predicted electrical degradation of power generated not exceeding 20% of the minimum rated power over the 25 year period and not more than 10% after ten years period of the full rated original output.

ARRAY STRUCTURE

a) Hot dip galvanized MS mounting structures may be used for mounting the modules/panels/arrays. Each structure should have angle of inclination as per the site conditions to take maximum insolation. However to accommodate more capacity the angle inclination may be reduced until the plant meets the specified performance ratio requirements.

b) The Mounting structure shall be so designed to withstand the speed for the wind zone of the location where a PV system is proposed to be installed (like Delhi-wind speed of 150 KM/ hour). It may be ensured that the design has been certified by a recognized Lab/Institution in this regard and submit wind loading calculation sheet to [NAME OF THE ORGANISATION]. Suitable fastening arrangement such as grouting and calming should be provided to secure the installation against the specific wind speed.

c) The mounting structure steel shall be as per latest IS 2062: 1992 and galvanization of the mounting structure shall be in compliance of latest IS 4759.

d) Structural material shall be corrosion resistant and electrolytically compatible with the materials used in the module frame, its fasteners, nuts and bolts. Aluminium structures also can be used which can withstand the wind speed of respective wind zone. Necessary protection towards rusting need to be provided either by coating or anodization.

e) The fasteners used should be made up of stainless steel. The structures shall be designed to allow easy replacement of any module. The array structure shall be so designed that it will occupy minimum space without sacrificing the output from the SPV panels.

f) Regarding civil structures the bidder need to take care of the load baring capacity of the roof and need arrange suitable structures based on the quality of roof.

g) The total load of the structure (when installed with PV modules) on the terrace should be less than 60 kg/m².

h) The minimum clearance of the structure from the roof level should be 300 mm.
JUNCTION BOXES (JBs)

a) The junction boxes are to be provided in the PV array for termination of connecting cables. The J. Boxes (JBs) shall be made of GRP/FRP/Powder Coated Aluminium /cast aluminium alloy with full dust, water & vermin proof arrangement. All wires/cables must be terminated through cable lugs. The JBs shall be such that input & output termination can be made through suitable cable glands.

b) Copper bus bars/terminal blocks housed in the junction box with suitable termination threads Conforming to IP65 standard and IEC 62208 Hinged door with EPDM rubber gasket to prevent water entry. Single / double compression cable glands. Provision of earthings. It should be placed at 5 feet height or above for ease of accessibility.

c) Each Junction Box shall have High quality Suitable capacity Metal Oxide Varistors (MOVs) / SPDs, suitable Reverse Blocking Diodes. The Junction Boxes shall have suitable arrangement monitoring and disconnection for each of the groups.

d) Suitable markings shall be provided on the bus bar for easy identification and the cable ferrules must be fitted at the cable termination points for identification.

DC DISTRIBUTION BOARD:

a) DC Distribution panel to receive the DC output from the array field.

b) DC DPBs shall have sheet from enclosure of dust & vermin proof conform to IP 65 protection. The bus bars are made of copper of desired size. Suitable capacity MCBs/MCCB shall be provided for controlling the DC power output to the PCU along with necessary surge arrestors.

AC DISTRIBUTION PANEL BOARD:

a) AC Distribution Panel Board (DPB) shall control the AC power from PCU/ inverter, and should have necessary surge arrestors. Interconnection from ACDB to mains at LT Bus bar while in grid tied mode.

b) All switches and the circuit breakers, connectors should conform to IEC 60947, part I, II and III/ IS60947 part I, II and III.

c) The changeover switches, cabling work should be undertaken by the bidder as part of the project.

d) All the Panel's shall be metal clad, totally enclosed, rigid, floor mounted, air - insulated, cubical type suitable for operation on three phase / single phase, 415 or 230 volts, 50 Hz

e) The panels shall be designed for minimum expected ambient temperature of 45 degree Celsius, 80 percent humidity and dusty weather.

f) All indoor panels will have protection of IP54 or better. All outdoor panels will have protection of IP65 or better.
g) Should conform to Indian Electricity Act and rules (till last amendment).

h) All the 415 AC or 230 volts devices / equipment like bus support insulators, circuit breakers, SPDs, VTs etc., mounted inside the switchgear shall be suitable for continuous operation and satisfactory performance under the following supply conditions:

- Variation in supply voltage: +/- 10%
- Variation in supply frequency: +/- 3 Hz

**PCU/ARRAY SIZE RATIO:**

a) The combined wattage of all inverters should not be less than rated capacity of power plant under STC.

b) Maximum power point tracker shall be integrated in the PCU/inverter to maximize energy drawn from the array.

**PCU/ Inverter:**

As SPV array produce direct current electricity, it is necessary to convert this direct current into alternating current and adjust the voltage levels to match the grid voltage. Conversion shall be achieved using an electronic Inverter and the associated control and protection devices. All these components of the system are termed the “Power Conditioning Unit (PCU)”.

In addition, the PCU shall also house MPPT (Maximum Power Point Tracker), an interface between Solar PV array & the Inverter, to the power conditioning unit/inverter should also be DG set interactive. If necessary. Inverter output should be compatible with the grid frequency. Typical technical features of the inverter shall be as follows:

- Switching devices: IGBT/MOSFET
- Control: Microprocessor /DSP
- Nominal AC output voltage and frequency: 415V, 3 Phase, 50 Hz (In case single phase inverters are offered, suitable arrangement for balancing the phases must be made.)
- Output frequency: 50 Hz
- Grid Frequency Synchronization range: + 3 Hz or more
- Ambient temperature considered: -20°C to 50°C
- Humidity : 95 % Non-condensing
- Protection of Enclosure: IP-20 (Minimum) for indoor.
- : IP-65 (Minimum) for outdoor.
- Grid Frequency Tolerance range : + 3 or more
- Grid Voltage tolerance : - 20% & + 15 %
- No-load losses : Less than 1% of rated power
o Inverter efficiency (minimum) : >93% (In case of 10kW or above)
o Inverter efficiency (minimum) : > 90% (In case of less than 10 kW)
o THD : < 3%
o PF : > 0.9

a) Three phase PCU/ inverter shall be used with each power plant system (10kW and/or above) but in case of less than 10kW single phase inverter can be used.
b) PCU/inverter shall be capable of complete automatic operation including wake-up, synchronization & shutdown.
c) The output of power factor of PCU inverter is suitable for all voltage ranges or sink of reactive power, inverter should have internal protection arrangement against any sustainable fault in feeder line and against the lightning on feeder.
d) Built-in meter and data logger to monitor plant performance through external computer shall be provided.
e) The power conditioning units / inverters should comply with applicable IEC/ equivalent BIS standard for efficiency measurements and environmental tests as per standard codes IEC 61683/IS 61683 and IEC 60068- 2(1,2,14,30) /Equivalent BIS Std.
f) The charge controller (if any) / MPPT units environmental testing should qualify IEC 60068-2(1, 2, 14, 30)/Equivalent BIS std. The junction boxes/ enclosures should be IP 65(for outdoor)/ IP 54 (indoor) and as per IEC 529 specifications.
g) The PCU/ inverters should be tested from the MNRE approved test centres / NABL /BIS /IEC accredited testing- calibration laboratories. In case of imported power conditioning units, these should be approved by international test houses.

INTEGRATION OF PV POWER WITH GRID:

The output power from SPV would be fed to the inverters which converts DC produced by SPV array to AC and feeds it into the main electricity grid after synchronization.

In case of grid failure, or low or high voltage, solar PV system shall be out of synchronization and shall be disconnected from the grid. Once the DG set comes into service PV system shall again be synchronized with DG supply and load requirement would be met to the extent of availability of power. 4 pole isolation of inverter output with respect to the grid/ DG power connection need to be provided.

DATA ACQUISITION SYSTEM / PLANT MONITORING

i. Data Acquisition System shall be provided for each of the solar PV plant.
ii. Data Logging Provision for plant control and monitoring, time and date stamped system data logs for analysis with the high quality, suitable PC. Metering and Instrumentation for display of systems parameters and status indication to be provided.
iii. Solar Irradiance: An integrating Pyranometer / Solar cell based irradiation sensor (along with calibration certificate) provided, with the sensor mounted in the plane of the array. Readout integrated with data logging system.

iv. Temperature: Temperature probes for recording the Solar panel temperature and/or ambient temperature to be provided complete with readouts integrated with the data logging system.

v. The following parameters are accessible via the operating interface display in real time separately for solar power plant:

   a) AC Voltage.
   b) AC Output current.
   c) Output Power.
   d) Power factor.
   e) DC Input Voltage.
   f) DC Input Current.
   g) Time Active.
   h) Time disabled.
   i) Time Idle.
   j) Power produced.
   k) Protective function limits (Viz-AC Over voltage, AC Under voltage, over frequency, under frequency ground fault, PV starting voltage, PV stopping voltage).

vi. All major parameters available on the digital bus and logging facility for energy auditing through the internal microprocessor and read on the digital front panel at any time) and logging facility (the current values, previous values for up to a month and the average values) should be made available for energy auditing through the internal microprocessor and should be read on the digital front panel.

vii. PV array energy production: Digital Energy Meters to log the actual value of AC/ DC voltage, Current & Energy generated by the PV system provided. Energy meter along with CT/PT should be of 0.5 accuracy class.

viii. Computerized DC String/Array monitoring and AC output monitoring shall be provided as part of the inverter and/or string/array combiner box or separately.

ix. String and array DC Voltage, Current and Power, Inverter AC output voltage and current (All 3 phases and lines), AC power (Active, Reactive and Apparent), Power Factor and AC energy (All 3 phases and cumulative) and frequency shall be monitored.
x. Computerized AC energy monitoring shall be in addition to the digital AC energy meter.

xi. The data shall be recorded in a common work sheet chronologically date wise. The data file shall be MS Excel compatible. The data shall be represented in both tabular and graphical form.

xii. All instantaneous data shall be shown on the computer screen.

xiii. Software shall be provided for USB download and analysis of DC and AC parametric data for individual plant.

xiv. Provision for Internet monitoring and download of data shall be also incorporated.

xv. Remote Server and Software for centralized Internet monitoring system shall be also provided for download and analysis of cumulative data of all the plants and the data of the solar radiation and temperature monitoring system.

xvi. Ambient / Solar PV module back surface temperature shall be also monitored on continuous basis.

xvii. Simultaneous monitoring of DC and AC electrical voltage, current, power, energy and other data of the plant for correlation with solar and environment data shall be provided.

xviii. Remote Monitoring and data acquisition through Remote Monitoring System software at the owner /[NAME OF THE ORGANISATION] location with latest software/hardware configuration and service connectivity for online / real time data monitoring/control complete to be supplied and operation and maintenance/control to be ensured by the supplier. Provision for interfacing these data on [NAME OF THE ORGANISATION] server and portal in future shall be kept.

TRANSFORMER “IF REQUIRED” & METERING:

a) Dry/oil type relevant kVA, 11kV/415V, 50 Hz Step up along with all protections, switchgears, Vacuum circuit breakers, cables etc. along with required civil work.

b) The bidirectional electronic energy meter (0.5 S class) shall be installed for the measurement of import/Export of energy.

c) The bidder must take approval/NOC from the Concerned DISCOM for the connectivity, technical feasibility, and synchronization of SPV plant with distribution network and submit the same to [NAME OF THE ORGANISATION] before commissioning of SPV plant.

d) Reverse power relay shall be provided by bidder (if necessary), as per the local DISCOM requirement.
POWER CONSUMPTION

a) Regarding the generated power consumption, priority need to give for internal consumption first and thereafter any excess power can be exported to grid. Finalization of tariff is not under the purview of [NAME OF THE ORGANISATION] or MNRE. Decisions of appropriate authority like DISCOM, state regulator may be followed.

PROTECTIONS

a) The system should be provided with all necessary protections like earthing, Lightning, and grid islanding as follows:

LIGHTNING PROTECTION

a) The SPV power plants shall be provided with lightning & overvoltage protection. The main aim in this protection shall be to reduce the over voltage to a tolerable value before it reaches the PV or other sub system components. The source of over voltages can be lightning, atmosphere disturbances etc. The entire space occupying the SPV array shall be suitably protected against Lightning by deploying required number of Lightning Arrestors. Lightning protection should be provided as per IEC 62305 standard. The protection against induced high-voltages shall be provided by the use of metal oxide varistors (MOV) and suitable earthing such that induced transients find an alternate route to earth.

SURGE PROTECTION

a) Internal surge protection shall consist of three MOV type surge arrestors connected from +ve and –ve terminals to earth (via Y arrangement)

EARTHING PROTECTION

a) Each array structure of the PV yard should be grounded/earthed properly as per IS:3043-1987. In addition the lighting arrester/masts should also be earthed inside the array field. Earth Resistance shall be tested in presence of the representative of Department/[NAME OF THE ORGANISATION] as and when required after earthing by calibrated earth tester. PCU, ACDB and DCDB should also be earthed properly.

b) Earth resistance shall not be more than 5 ohms. It shall be ensured that all the earthing points are bonded together to make them at the same potential.

GRID ISLANDING:

a) In the event of a power failure on the electric grid, it is required that any independent power-producing inverters attached to the grid turn off in a short period of time. This prevents the DC-to-AC inverters from continuing to feed power into small sections of the grid, known as “islands.” Powered islands present a risk to workers who may expect the area to be unpowered, and they may also damage grid-tied equipment. The Rooftop PV system shall be equipped with islanding protection. In addition to disconnection from the grid (due to islanding protection) disconnection due to under and over voltage conditions shall also be provided.
b) A manual disconnect 4pole isolation switch beside automatic disconnection to grid would have to be provided at utility end to isolate the grid connection by the utility personnel to carry out any maintenance. This switch shall be locked by the utility personnel.

**CABLES**

Cables of appropriate size to be used in the system shall have the following characteristics:

a) Shall meet IEC 60227/IS 694, IEC 60502/IS1554 standards

b) Temp. Range: $-10^\circ$C to $+80^\circ$C.

c) Voltage rating 660/1000V

d) Excellent resistance to heat, cold, water, oil, abrasion, UV radiation

e) Flexible

f) Sizes of cables between array interconnections, array to junction boxes, junction boxes to Inverter etc. shall be so selected to keep the voltage drop (power loss) of the entire solar system to the minimum. The cables (as per IS) should be insulated with a special grade PVC compound formulated for outdoor use.

g) Cable Routing/ Marking: All cable/wires are to be routed in a GI cable tray and suitably tagged and marked with proper manner by good quality ferule or by other means so that the cable easily identified.

h) The Cable should be so selected that it should be compatible up to the life of the solar PV panels i.e. 25years.

i) The ratings given are approximate. Bidder to indicate size and length as per system design requirement. All the cables required for the plant provided by the bidder. Any change in cabling sizes if desired by the bidder/approved after citing appropriate reasons. All cable schedules/layout drawings approved prior to installation.

j) Multi Strand, Annealed high conductivity copper conductor PVC type ‘A’ pressure extruded insulation or XLPE insulation. Overall PVC/XLPE insulation for UV protection Armoured cable for underground laying. All cable trays including covers to be provided. All cables conform to latest edition of IEC/ equivalent BIS Standards as specified below: BoS item / component Standard

k) Description Standard Number Cables General Test and Measuring Methods, PVC/XLPE insulated cables for working Voltage up to and including 1100 V ,UV resistant for outdoor installation IS /IEC 69947.

l) The size of each type of DC cable selected shall be based on minimum voltage drop however; the maximum drop shall be limited to 1%.
m) The size of each type of AC cable selected shall be based on minimum voltage drop however; the maximum drop shall be limited to 2%.

CONNECTIVITY

The maximum capacity for interconnection with the grid at a specific voltage level shall be as specified in the Distribution Code/Supply Code of the State and amended from time to time. Following criteria have been suggested for selection of voltage level in the distribution system for ready reference of the solar suppliers.

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<td>Up to 10 kW</td>
<td>240V-single phase or 415V-three phase at the option of the consumer</td>
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<tr>
<td>Above 10kW and up to 100 kW</td>
<td>415V – three phase</td>
</tr>
<tr>
<td>Above 100kW</td>
<td>At HT/EHT level (11kV/33kV/66kV) as per DISCOM rules</td>
</tr>
</tbody>
</table>

a) The maximum permissible capacity for rooftop shall be 1 MW for a single net metering point.

b) Utilities may have voltage levels other than above, DISCOMS may be consulted before finalization of the voltage level and specification be made accordingly.

c) For large PV system (Above 100 kW) for commercial installation having large load, the solar power can be generated at low voltage levels and stepped up to 11 kV level through the step up transformer. The transformers and associated switchgear would require to be provided by the SPV bidders.

DANGER BOARDS AND SIGNAGES:

Danger boards should be provided as and where necessary as per IE Act. /IE rules as amended up to date. Three signage shall be provided one each at battery –cum- control room, solar array area and main entry from administrative block. Text of the signage may be finalized in consultation with [NAME OF THE ORGANISATION]/ owner.

FIRE EXTINGUISHERS:

The firefighting system for the proposed power plant for fire protection shall be consisting of:

a) Portable fire extinguishers in the control room for fire caused by electrical short circuits

b) Sand buckets in the control room

c) The installation of Fire Extinguishers should confirm to TAC regulations and BIS standards. The fire extinguishers shall be provided in the control room housing PCUs as well as on the Roof or site where the PV arrays have been installed.
DRAWINGS & MANUALS:

a) Two sets of Engineering, electrical drawings and Installation and O&M manuals are to be supplied. Bidders shall provide complete technical data sheets for each equipment giving details of the specifications along with make/makes in their bid along with basic design of the power plant and power evacuation, synchronization along with protection equipment.

b) Approved ISI and reputed makes for equipment be used.

c) For complete electro-mechanical works, bidders shall supply complete design, details and drawings for approval to [NAME OF THE ORGANISATION]/owners before progressing with the installation work

PLANNING AND DESIGNING:

The bidder should carry out Shadow Analysis at the site and accordingly design strings & arrays layout considering optimal usage of space, material and labor. The bidder should submit the array layout drawings along with Shadow Analysis Report to [NAME OF THE ORGANISATION]/Owner for approval.

a) [NAME OF THE ORGANISATION] reserves the right to modify the landscaping design, Layout and specification of sub-systems and components at any stage as per local site conditions/requirements.

b) The bidder shall submit preliminary drawing for approval & based on any modification or recommendation, if any. The bidder submit three sets and soft copy in CD of final drawing for formal approval to proceed with construction work.

DRAWINGS TO BE FURNISHED BY BIDDER AFTER AWARD OF CONTRACT

a) The Contractor shall furnish the following drawings Award/Intent and obtain approval

b) General arrangement and dimensioned layout

c) Schematic drawing showing the requirement of SV panel, Power conditioning Unit(s)/inverter, Junction Boxes, AC and DC Distribution Boards, meters etc.

d) Structural drawing along with foundation details for the structure.

e) Itemized bill of material for complete SV plant covering all the components and associated accessories.

f) Layout of solar Power Array

g) Shadow analysis of the roof

SOLAR PV SYSTEM ON THE ROOFTOP FOR MEETING THE ANNUAL ENERGY REQUIREMENT

The Solar PV system on the rooftop of the selected buildings will be installed for meeting upto 90% of the annual energy requirements depending upon the area of rooftop available and the
remaining energy requirement of the office buildings will be met by drawing power from grid at commercial tariff of DISCOMs.

SAFETY MEASURES:

a) The bidder shall take entire responsibility for electrical safety of the installation(s) including connectivity with the grid and follow all the safety rules & regulations applicable as per Electricity Act, 2003 and CEA guidelines etc.
CONSTRUCTION OF INCUBATION CENTRE FOR SOFTWARE TECHNOLOGY PARK OF INDIA (STPI)

AT

PLOT NO. 4&5, SECTOR-7, GIDA, GORAKHPUR

VOLUME – 2, Part III
(HVAC WORKS)
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1. TENDER NUMBER ____________________________

2. DATE OF ISSUE ____________________________

3. TENDER ISSUED TO _________________________

                                  ____________________________
INTRODUCTION TO PROJECT

1. **General**

This document pertains to supply, installation, testing and commissioning of HVAC system and intended to be read in conjunction with the relevant IS codes and IS Specifications (latest).

2. **Details of Site**

The site is situated at Gorakhpur.

3. **Contractor’s Scope of Work**

The scope of work proposed under this contract includes supply, installation, testing and commissioning of the complete HVAC system as elaborated in design drawings, detailed specifications and bill of quantities.

The scope shall cover Supply and Installation of all necessary equipment including Variable Refrigerant Volume (VRV) system comprising of Outdoor & Indoor Units, HRV Units, PAC Units, Conventional Split Units, Copper Refrigerant Piping, Condensate Drain Piping, Inline Fans and Propeller Fans etc.

Scope of work also includes supply, fabrication and installation of GSS ductwork, grilles/diffusers and insulation as required.

Routine testing, pressure testing of fabricated components, balancing and Commissioning of the entire HVAC system and performance testing as per system requirement shall also be covered in the scope.

The Contractor shall be responsible to complete the entire work under scope in all respect in line with the contract documents and with the directions of and to the satisfaction of the Architects/Consultants and Owners.

The Contractor shall furnish all labour, materials and equipment (except those to be supplied by the Owners, if any) as listed under bill of quantities and specified otherwise, transportation and incidental necessary for supply, installation, testing and commissioning of complete HVAC system.

The scope shall also cover supply and installation of materials, equipment, appliances and incidental work not specifically mentioned herein or noted on the drawings or documents as being furnished or installed, but which are necessary and customary to make a complete installation. Supply of such material/equipment and execution shall be carried out in accordance with the most latest IS codes and IS specifications. In the event of non availability of relevant IS codes/specifications, good engineering practices shall be adopted.

4. **Items to be provided by other agencies**: 

The following activities associated with the said contract shall be carried out by other agencies under direct supervision of the AC contractor:
4.1 **Civil Works:**

All associated civil works listed below shall be carried out by civil/interior contractor:

4.1.1 Foundation for VRV Outdoor Units & AHUs including PCC/RCC blocks as required or as mentioned in the BOQ.

4.1.2 False ceiling work.

4.1.3 Providing aluminium channel trough in the false ceiling for fixing of diffusers and GI frame work in walls/partitions for fixing of grilles.

4.1.4 Providing opening in walls/slabs for crossing of ducts/piping and making them good & finished.

4.2 **Plumbing Works:**

All associated plumbing works listed below shall be carried out by plumbing contractor.

4.2.1 Providing floor trap for termination of condensate drain piping associated with DX, VRV indoor units and split units to be carried out by the AC contractor.

4.2.2 Providing appropriate cutout in the wall to facilitate lying and termination of condensate drain piping outside the Technical area.

4.3. **Electrical Works:**

All associated electrical works listed below shall be carried out by electrical contractor:

4.3.1 Providing 415 + 10 % volts, 50 Hz, 3 phase stabilised power supply at each VRV ODU, ventilation fan panel & Hi-wall type split units with scroll compressor to be installed in balcony or other suitable place in the form of power cabling and necessary earthing.

4.3.2 Providing 415 + 10 % volts, 50 Hz, 3 phase stabilised power supply at each PAC Unit in the form of power cabling and necessary earthing along with TPN MCCB of suitable rating.

4.3.3 Providing 220 ± 6 % volts, 50 Hz, 1 phase power point near each indoor unit, non ductable split units with rotary compressor, propeller fan and inline fan for toilet exhaust as shown in the design drawings.

******************************************************************************************
CONDITIONS OF THE CONTRACT

1. Date of Commencement

Within 3 days from the date of award of work

2. Period of completion

i) The entire air conditioning to be completed within 3.0 (Three) Months from the date of award of work.

ii) However, fabrication and installation of entire duct work and refrigerant piping including application of insulation has to be completed within 8 (Eight) weeks from the date of award of work. Entire work including testing and commissioning shall be completed in all respects within 3.0 Months from the award of work.

3. Defects liability period.

One Year after the virtual completion of the work as certified by the Architect/ Consultant.

4. Liquidated damage

In the event of delays Liquidated Damages shall be charged by the owner Agency from the contractor as follows:

i) Entire HVAC work:

In case the work as a whole is not completed within stipulated period of 3 months from date of start then the contractor will be liable to pay an amount equal to 1. 0 % (one percent) of the total tendered amount per week of delay subject to a maximum of 10% of the total contract value.

5. Retention money

5 % (including earnest money, if any) to be deducted from each running bill subject to maximum of Rs. 8,75,000/- (Rupees Eight Lac & Seventy Five Thousand Only) out of which 50 % amount will be released after six months of virtual completion and rest 50 % amount will be released after satisfactory completion of the defects liability period.

6. Terms of Payment

The following terms of Payment shall be adhered to:

High Side (Supply of machines)

i. 10% Along with PO

ii. 90% against proforma Invoice on readiness of dispatch.
Low Side

i. 10% as mobilization advance against a bank guarantee of equal amount valid till completion of the project.

ii. 5% against approval of all shop drawings and technical submittals.

iii. 60% against delivery of equipment/material at site on pro rata basis.

iv. 15% against erection of equipment/material on pro rata basis.

v. 10% against satisfactory testing and commissioning of entire HVAC work and submission & approval of “As Built Drawings and Completion Documents”.

7. Escalation

This being a firm offer, the contractor will not be entitled for any escalation. No escalation/change of prices would be admissible under any circumstances.

8. Quantities

a) Quantities of items listed in schedule of Quantities may be increased, reduced or omitted to any extent. Exact quantity of every item shall be measured and paid as per actual work done at site.

b) The owner reserves the right to exclude any items from the scope of work of the main contract and may appoint a sub-contractor for the work directly.

c) All tenders in which any of the prescribed conditions are not fulfilled are liable to be rejected.

9. Taxes

The contractor shall bear the amount of GST or any other tax octroi legally payable and it shall be assumed that his rates cover for all taxes and duties and no claim on this account will be entertained.

If the work contract tax as applicable on work at the time of award of work is increased / decreased, the same will be reimbursable to/recoverable from the contractor.

The Owner shall deduct taxes at source at the time of payment from the contractor’s bill as per prevailing laws. **The tax shall be deducted on total work done (contract amount) including the cost of material supplied by owner**

10. PF and ESI Returns

Filing of provident fund and ESI Returns with concerned departments shall be the responsibility of the contactor which shall be approved by the owner / Architect.

11. Extra item
The extra item rates shall either be derived from the tender item or substantiated by a detailed rate analysis at market rates and to be got approved from the Architects/Consultants.

12. **Engineering Responsibility of the system**

The responsibility of system design, manufacturing, erection, working and safety will solely be responsibility of the Contractor for the parameters as mentioned in the tender documents prepared by the consulting engineers.

The system after commissioning shall be handed over to the Owners and thereafter they will monitor the performance for standard designed parameters for 30 days continuously. In case during this period the performance is not found satisfactory and rectification/ replacement, design improvement or any other change is felt necessary, will be made by the Contractor at no extra cost to the Owner. Though these improvements can only be done after getting the approval from the Owners/Architects.

13. **Liability to Govt. Regulations**

The Contractor shall be responsible and shall abide by all the government rules and regulations pertaining to erection, testing and commissioning of complete HVAC system at site. Any compensation towards damage/loss of property/ material/equipment or to any person working at site shall be borne by the Contractor as per standard terms of contract.

14. **Store**

A lockable storage space shall be provided by the Clients but safe custody shall be the responsibility of the contractor till the installation is taken over.

15. **Certificate of Inspection**

The contractor shall obtain and deliver to the owner, a certificate of final inspection by the local authorities concerned, if required at site. The inspection fee shall be reimbursed as per actual on the production of receipt in original.

Further the Owners/Architects shall have full powers to order the materials or work to be tested by an independent agency at the Contractors expense in order to prove its fault & in-adequacy.

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TECHNICAL CLAUSES

1. Design Drawings

The drawings prepared by the Consultants are indicative only of the general arrangement of the entire installation. The Contractor shall follow these drawings and specifications in preparation of his shop drawings and subsequent installation. He shall check the drawings of other trades to verify space for his installation. The Contractor shall examine all relevant architectural, structural, plumbing, electrical and other services layout drawings before preparing the shop drawings for this installation, and report to the Architects/Consultants any discrepancy and obtain clarifications. Any changes found necessary for co-ordination and installation of this work with other services and trades shall be made with prior approval of the Architects/Consultants and Owner without any additional cost to the Owner.

2. Site visit & Shop Drawings

The contractor shall visit the site and shall satisfy himself as to condition under which work is to be performed. No claim for consequences of ignorance at the later date shall be entertained. He should also check and ascertain the location of existing structure or equipment or any other situation which may effect the work.

The contractor shall submit five sets of shop drawings for air distribution system layout, Electrical panels & Equipment Layout drawings for approval of the Owners/Architects. Contractor shall also submit technical submittals for all major items including VRV Units, HRV Units, Split units, ventilation fans, inline fans, piping, Ducting & GS sheet, grilles, diffusers, fire dampers, insulation material, electrical components etc. for the approval of the Owners/Architects.

Five sets of detailed shop drawings of all equipment and materials including ducting, piping, ventilation system, electrical work associated with the HVAC system required to complete the project as per specifications and as required by the Architect/Consultant. These drawings shall contain details of construction, size, arrangement, operating clearances, performance characteristics and capacity of all equipment, also the details of all related items of work by other Contractors. Each item of equipment proposed shall be a standard catalogue product of an established manufacturer as per specifications.

If the Architect/Consultants makes any amendment in the above drawings, the contractor shall supply two fresh sets of drawings with the amendments duly incorporated, along with the drawings on which corrections were made. After final approval has been obtained from the Architect/Consultant, the Contractor shall submit a further six sets of shop drawings for the exclusive use of and retention by the Architect/Consultant. No material or equipment may be delivered or installed at the job site until the contractor has in his possession, the approved shop drawings for the particular material or equipment.

The shop drawings shall be submitted for approval sufficiently in advance of planned delivery and installation of any material to allow Architects/Consultants ample time for scrutiny. No claims for extension of time shall be entertained because of any delay in the work due to his failure to produce shop drawings at the right time, in accordance with the approved CPM charts.
Samples, drawings, specifications, catalogues, pamphlets and other documents submitted for approval shall be in quadruplicate, each item in each set shall be properly labeled, indicating the specific service for which material or equipment is to be used, giving reference to the governing section and clause number of Specifications clearly identifying in ink the items and the operating characteristics. Data of a general nature shall not be accepted.

Approval rendered on shop drawings shall not be considered as a guarantee of measurements of building conditions. Where drawings are approved, said approval does not mean that drawings have been checked in detail nor does it any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the contract.

Where the Contractor proposes to use an item of equipment other than that specified or detailed on the drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout, all such redesign and all new drawings and detailing required thereof, shall be prepared by the Contractor at his own cost and approved by the Architect/Consultant.

Where the work of the Contractor has to be installed in close proximity to, or will interfere with work of other trades, he shall assist in working out space conditions to make satisfactory adjustments. If so directed by the Architect/Consultant, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than 1:50, clearly showing how his work is to be installed in relation to the work of other trades. If the Contractor installs his work before coordinating with other trades, or so as to cause any interference with work of other trades, he shall make all the necessary changes without extra cost to the Owner.

Within two weeks of approval of all the relevant shop drawings, the Contractor shall submit to the Architect/Consultant four copies of comprehensive itemized price list of recommended imported and local spare parts and tools covering all equipment and materials in this contract. The Owner shall make arrangements to procure these spare parts and tools.

3. **Material & Workmanship**

All material used in work shall be of the best quality, obtainable and of approved list of manufacturers and shall conform to latest Indian Standard specifications unless otherwise stated.

4. **Erection and Supervision**

The Contractor shall depute engineers from time to time of commencement of installation work to inspect all relevant foundation/fabrication and other necessary facilities to make improved action if felt necessary. However, a qualified experienced engineer to be deputed at site beginning from commencement of HVAC activities at site & till handing over of the project.

5. **Testing and Commissioning**
On completion, the installation shall be tested for conformity with the stipulated performance specifications. Any defect, shortcoming detected in the system/material/workmanship shall be rectified by the Contractor to the entire satisfaction of the Consultants without any extra cost to the Owner. The installation shall be tested again after the removal of the defects and shall be commissioned only after approval by competent inspecting authority or the Consultants and the Owner. All tests shall be carried out in the presence of the Consultants and Owner’s representative.

Testing and commissioning shall include furnishing all labour, materials, instruments etc. and incidentals necessary for complete testing of each component as per the specifications and manufacturer’s recommendations.

Maintenance Services for the complete HVAC installation shall be provided during the defects liability period of one year.

The initial tests shall include but not be limited to the following:

i. To operate & check the proper functioning of all electrically operated components like compressor motor, pumps, blowers, fans and other electrical motors etc.

ii. To test and check the switchgears etc. and other safety & control devices ensuring proper functioning.

iii. To check and balance the water flow in the water circuits so that flow rate through various equipments is as per design.

iv. To check for leaks in the system & perform pressure testing.

v. To check alignment of motors, Belts and other dynamic equipments.

vi. To check all control settings to ensure smooth & proper functioning of the system.

6. **Samples & Technical Submittals**

   Samples, make or brand of all the materials must be got approved by the Architect/Consultants/Owner in writing before they are brought to the site. Nothing extra shall be paid for presenting samples of any item as desired by Owner/Architect/Consultants.

   Technical submittals of all the major items or as desired by the Architects/Consultants incorporating complete technical details in line with the tender specifications & catalogue prior to procurement of equipment/material shall be submitted for the approval.

7. **Contradiction between BOQ, Specifications and Drawings :**

   In the event of conflicts between BOQ, Specifications and Drawings, the BOQ shall take precedence over the specifications and drawings. Keeping the general intent of the scope of work under said contract, the Architects/Consultants would interpret the requirements of the design intent & contract and their decision shall be final and acceptable to all concerns including the contractors.
8. Owner reserve the right to relax or modify any condition listed in conditions of the contract in overall interest of the work.

9. All tools, plant and machinery provided by the contractor shall, when brought to the site, be deemed to be exclusively intended for construction and completion of this work and the contractor shall not remove the same or any part thereof without the consent of the Architect / Owner.

10. The rates quoted by the contractor shall be all inclusive keeping in mind the specifications, additional and special conditions in view and nothing extra shall be payable whatsoever.

11. Unless otherwise provided in the schedule of quantities the rates tendered by the contractor shall be all inclusive and shall apply to all heights, lifts, leads and depths of the building. Nothing extra shall be payable to him on this account.

12. The equipments erected, commissioned at site should be suitable for maximum temperature of 50 degree C.

13. The electrical installation shall be carried out in accordance with Indian electricity rules, relevant Indian standard such as IS 732, IS 3043 and the requirements stipulated by local statutory body such as electrical inspectors for such installations. It is to be clearly understood that the final responsibility for sufficiency, adequacy, and conformity to the performance of the HVAC system shall be with the Contractor.

14. The equipment and materials to be supplied shall conform to the requirements of the relevant IS standards.

15. The work shall be executed strictly as per the specifications drawn and “Approved for Construction Shop Drawings” and to the entire satisfaction of the Owners/Architects.

16. Completion Drawings & Documents - After completion of the work, the contractor shall furnish four sets of completion documents complete with “As Built Drawings”.

17. The contractor shall ensure good conduct of the workman at the site of work.
A. "SPECIFICATIONS- MAIN EQUIPMENT"

1. VARIABLE REFRIGERANT VOLUME SYSTEM

   **Scope**

   The scope shall be supply, installation, testing and commissioning of air cooled variable refrigerant Volume (VRV) system conforming to these specifications and meeting all design parameters as mentioned in the “Bill of Quantities” and drawings. Variable Refrigerant Volume System shall be a standard product, however all these specifications shall fully comply.

   **Type**

   Unit shall be heat pump type consisting of outdoor units and multiple indoor units, each suitable to facilitate cooling during summer & monsoon and heating in winter as per the requirements.

   It shall be possible to connect minimum 10 indoor units on one refrigerant circuit. The indoor units on any circuit can be of different type and also controlled individually.

   Compressor installed in outdoor units shall be equipped with all inverter compressors up to 20 HP and in bigger machines for higher reliability, improved life, better backup and duty cycling purpose. The system shall be capable of changing the rotating speed of inverter compressor by inverter controller to follow variations in cooling and heating load.

   Outdoor unit shall be suitable for mix match connection of all type of indoor units.

   The refrigerant piping between indoor units and outdoor unit shall be possible to extend up to 165M with maximum 50M level difference **without any oil traps**.

   Both indoor units and outdoor unit shall be factory assembled, tested and filled with first charge of refrigerant gas before delivering at site.

   Units shall be factory finished with paint as per manufacturer’s standard. However, shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirit, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop painted surfaces.

   **Capacity**

   The refrigeration capacity of VRV outdoor and indoor units shall be as mentioned in the “Bill of Quantities” and as reflected on the drawings.

   **Outdoor Unit**

   The unit shall be heat pump type with automatic changeover in different seasons.
The outdoor unit shall be a factory assembled unit housed in a sturdy weather proof casing constructed from rust-proofed heavy gauge mild steel panels coated with a baked enamel finish. The unit should be completely factory wired, tested with all necessary controls.

All outdoor units shall have minimum two scroll compressors and be able to operate even in case of breakdown of one compressor. In case of outdoor units above 20HP, the outdoor unit shall have multiple inverter compressors so that the operation is not disrupted with failure of any compressor and if one compressor malfunctions, other continues to provide emergency operation smoothly till repair is effected. The unit shall be provided with duty cycling arrangement for multiple inverter compressors to facilitate sequenced operation of the machine for better stability and prolonged life.

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 microprocessors control panel.

The outdoor unit should have anti-corrosion paint free steel plate for easy mounting of unit.

The machine must have sub cool feature to use coil surface more effectively thru proper circuit/bridge so that it prevents the flushing of refrigerant from long piping due to this effect thereby achieving energy savings.

The outdoor unit should be fitted with low noise, aero spiral design fan with grill for spiral discharge airflow to reduce pressure loss and should be fitted with DC fan motor for better efficiency. The noise level shall not be more than 60dB (A) at normal operation measured horizontally 1M away and 1.5M above ground. For Residential application or wherever night operation is required the unit shall be suitable to operate on nighttime quiet operation mode having minimum three step of operation sound level i.e. 55dB to 45dB. Wherever required or as shown on the drawings the unit shall be selected for high external static pressure (ESP) not less than 78Pa (8mm WG) to meet long exhaust duct connection requirement.

The outdoor unit shall be designed to operate safely when connected to multiple fan coil units.

The unit shall be suitable to operate on environment friendly R 410A refrigerant.

**Compressor**

The compressor shall be highly efficient, high COP scroll type and capable of inverter control. The inverter compressor shall change the speed in accordance to the variation in cooling or heating load requirement.

All outdoor unit shall have multi-steps of capacity control to meet load fluctuation and indoor unit individual control. All parts compressor shall be sufficiently lubricated stock. Forced lubrication may also be employed.

Oil heater shall be provided in the compressor casing.

Inverter compressor shall preferably by Reluctance DC inverter compressor for higher efficiency and improved reliability.

**Heat Exchanger**
The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminum fins to form a cross fin coil. The aluminum fins shall be covered by anti-corrosion resin film. The unit should be with e-pass heat exchanger to optimize the path of heat exchanger and for better efficiency of condenser. 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.

**Refrigerant Circuit**

The refrigerant circuit shall include an accumulator, liquid and gas shut off valves and a solenoid valves at condenser end. The equipment must have in built refrigerant stabilization control for proper refrigerant distribution.

All necessary safety devices shall be provided to ensure the safety operation of the system.

**Safety Devices**

VRV system shall be provided with all safety devices as required and to ensure safe operation of the system, but not restricted to the following:

a. High pressure switch.
b. Low pressure switch.
c. Fuse.
d. Fan drive overload protector.
e. Fusible plug
f. Overload relay.
g. Overload protection for inverter.
h. Fan motor safety thermostat

**Oil Recovery System**

Each unit shall be equipped with an oil recovery system to ensure stable operation with long refrigerant piping.

The system must be provided with oil balancing circuit to avoid poor lubrication.

**Anti-corrosion Treatment**

Outdoor units should be designed with anti-corrosion specifications as detailed below for use in area, which are subject to salt damage and atmospheric pollution as specified in the BOQ.

The portion of machines like side panel, outer panel, bottom frame, which are exposed to corrosive atmosphere, should be of alloyed hot-dip zinc coated steel plate, coated with corrosion protection powder polyester resin coating on both inner and outer surfaces in thickness of 64 micron or more.

Finned coil protection net should have coating of resin coating containing ultraviolet ray absorbent. Fan and its fan protective net should be with weather resistant polypropylene resin.
The copper pipe – aluminium fins shall be special acrylic resin coated and internal supports, frame, control box shall also be hot-dip zinc coated steel plate and with rust preventive powder coating of 64 micron or more on inner and outer surfaces.

All screws and bolts used in outdoor unit shall be provided with SUS410, Zinc-nickel alloy plating, zinc chrome acid film treatment and rust inhibitor coating.

**Indoor Units**

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 detail Bill of Quantities.

Indoor unit shall be either ceiling mounted cassette type, or ceiling mounted ductable type or floor standing type or wall mounted type or other as specified in BOQ. Each unit shall have electronic control valve to control refrigerant flow rate respond to load variations of the rooms. The indoor units shall have following features:

a. The address of the indoor unit shall be set automatically in case of individual and group control.

b. In case of centralized control, it shall be set by liquid crystal remote controller.

c. 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.

d. The cooling coil shall be made out of seamless copper tubes and have continues aluminium 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 expended for minimum thermal contact resistance with fins. Each coils shall be factory tested at 21kg/sqm air pressure under water.

e. Unit shall have cleanable type filter fixed to an integrally moulded plastic frame. The filter shall slide away type and neatly inserted.

f. 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.

g. Each unit shall be with wired LCD type remote controller. The remote controller shall memorize the latest malfunction code for easy maintenance. The controller shall have self diagnostic features for easy and quick maintenance and service. The controller shall be able to change fan speed and angle of swing flap individually as per requirement.

The indoor units shall generally be of following type:

**Ceiling Mounted Ductable Type Unit**

Each Indoor unit shall be ceiling mounted ducted type, as specified in scope of work. It shall have electronic control valve to control refrigerant flow rate in response to load variations of the
The fan shall be of the dual suction multi blade type and statically and dynamically balanced to ensure low noise and vibration free operation. The unit shall have high static fan for Ductable arrangement.

**Ceiling Mounted Cassette Type Unit (Multi Flow/ Round Flow Type)**

The unit shall be ceiling mounted type. The unit shall include pre-filter, fan section and DX-coil section. The housing of the unit shall be powder coated galvanized steel. The body shall be light in weight and shall be able to suspend from four corners. The fan shall be aerodynamically designed diffuser turbo fan type. Noise level should not be more than 35 dB at low speed.

Unit shall have an external attractive panel for supply and return air. Unit shall have four way supply air grilles on sides and return air grille in center.

Each unit shall have high lift drain pump, fresh air intake provision (if specified) Low gas detection system and very low operating sound.

All the indoor units regardless of their difference in capacity should have **same decorative panel size** for harmonious aesthetic point of view. It should have provision of connecting branch ducts.

**Ceiling Suspended Type**

Unit shall be suitable for ceiling suspended arrangement below false ceiling.

The units include pre filter, fan section & DX-coil section. The housing of unit shall be light weight powder coated galvanized steel.

**High Wall Mounted Units**

The unit 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.

**Floor Standing Type**

Unit shall be suitable for floor standing arrangement. The units include pre filter, fan section & DX-coil section. The housing of unit shall be light weight powder coated galvanized steel.

**Centralized Type Remote Controller**

(Optional, if specified in BOQ)

A multifunctional compact centralized controller shall be provided with the system.

The controller must be necessarily a graphic Controller type to act as an advanced air-conditioning management system to give complete control of VRV air-conditioning Equipment. It should have case of use for the user and must have a user friendly colored touch screen, icon display and color LCD display.
a. It shall be able to control up to 64 groups of indoor units with the following functions:

b. Starting/Stopping of Air-conditioners as a zone or group or individual unit.

c. Temperature settling for each indoor unit or zone.

d. Switching between temperature control modes, switching of fan speed and direction of airflow, enabling/disabling of individual remote controller operation.

e. Monitoring of operation status such as operation mode & temperature setting of individual indoor units, maintenance information, trouble shooting information.

f. Display of air conditioner operation history.

g. Daily management automation through yearly schedule function with possibility of various schedules.

h. The controller shall have wide screen user friendly color LCD (Liquid Crystal Display) and can be wired by a non polar 2 wire transmission cable to a distance of 1 KM away from indoor unit.

Heat Reclaim Ventilation Unit.

In order to achieve the purpose of better indoor air quality, the Heat Reclaim ventilation (HRV) unit must exchange the heat between supplied fresh air and exhausted air in order to bring the outside air closer to indoor temperature and humidity conditions. Thus it must recover the thermal energy of exhaust air and reuse it for supplied fresh air. This must lead to ventilation without increasing the load and thus saving in running cost.

It shall be possible to interlock this HRV system with operation of VRV system to simplify installation and improving the efficiency of air-conditioning. It shall be possible to set automatic ventilation mode so that heat exchange mode and ventilation mode can be automatically selected to enhance energy conservation.

The casing of the HRV unit shall be made of galvanized steel plate, insulation with self extinguishable polyurethane foam. The HRV must have air filters of multi directional fibrous fleeces type.

The heat exchanger element must be designed without any moving parts for higher durability and reliability. It should have high permeability high efficiency specially processed paper which is flame retardant and fungi proof to keep air clean.

The unit must be provided with built in multi directional fibrous filter.

The unit must have optimized design of fan and air flow passage to make it compact and supply air & exhaust air passage must be arranged in such pattern so as to prevent mixing of supply (fresh) and exhaust air.

The unit must be suitable for single phase power supply and have their control panel.
2. **SPLIT UNITS**

**Scope**

The scope of this section comprises supply, installation, testing and commissioning of self contained air cooled split type air conditioning units each comprising of an outdoor and single/twin indoor units conforming to these specifications and in accordance with the requirement of drawings and schedule of quantities.

**Outdoor Unit**

Outdoor unit shall be an air cooled condensing unit suitable for outdoor installation conforming to the following specifications.

a. **Unit Base & Casing**

Base panel shall be constructed out of fabricated steel structure of adequate size. Casing panels shall be of 1.2 mm thick, welded construction, removable type to provide easy access to equipment and shall be bonderized and painted. Casing shall be complete with discharge outlets, grilles, space for refrigeration equipment, fans, condenser coil etc.

b. **Compressor**

i. **Scroll Compressor**

The scroll compressor shall be an industrial quality rugged, cast iron, direct hermetic compressor with scroll plates, suction & discharge service valves. The compressor shall be complete with straight suction tube, centrifugal oil pump, oil charging valve, oil level sight glass, crank case heater and check valve on the scroll discharge port. The compressor shall be complete with the provision of two-point lubrication for each motor bearing. The compressor shall be completely enclosed in a chamber with no leakage path and providing the capability for scroll plates to separate. The compressor shall be provided with industrial solid motor mounts internal motor protection and vibration isolation pads. Each compressor shall be independently wired and piped to its own circuit for efficient operation & ease of maintenance. The compressor speed shall not exceed 3000 RPM.

ii. **Rotary Compressor**

The rotary compressor shall be an industrial quality rugged, cast iron, hermetic/semi hermetic compressor with capacity control side valve, oil sump heater & differential pressure refrigerant oil flow system. The compressor shall be provided with multiple pressure lubricated rolling element bearing group shall support the rotating assembly. Suitable overload protection shall be provided & necessary isolating valves shall be provided at suction & discharge. The compressor shall be fitted with electrically operated oil heaters with built in thermostats. The heaters shall be automatically actuated when the compressor is stopped. Necessary time delay shall be provided for restart of compressor. The compressor shall be provided with industrial solid motor mounts internal motor protection and vibration isolation pads. Each compressor shall be independently wired and piped to its own circuit for efficient operation & ease of maintenance. The compressor speed shall not exceed 3000 RPM.
c. **Condenser**

Condenser shall be air cooled in copper tube & aluminium fins construction. Condensers shall be complete with provisions for refrigerant piping connections, shut off valves and any other standard accessory necessary with the equipment supplied.

d. **Condenser Fan**

Fan shall be preferably propeller type suitable for fractional horse power drive with IP-55 protection.

**Indoor Unit**

The indoor unit shall be basically a fan coil unit suitable for wall, floor and under ceiling installation of various types conforming to the following specifications.

a. Indoor units shall be either ceiling mounted cassette type, wall mounted type, floor mounted type or ceiling mounted ductable type in conformity with the design drawings and schedule of quantities.

Each indoor unit shall consist of PID controller for maintaining design room conditions besides microprocessor based thermostat for cooling. The indoor unit shall also be provided with wired LCD type remote controller which shall memorize the latest malfunction code for ease in maintenance. The controller shall incorporate self diagnostic features. Such remote controllers associated with cassette type and hi-wall type indoor units shall incorporate inbuilt feature to be able to change fan speed and angle of swing flap individually as desired by the user.

The ceiling mounted cassette type indoor units shall comprise of an attractive moulded ABS plastic exterior enclosure provided with four way supply air grilles on the periphery and square return air grill at the centre with filter behind. Each cassette type indoor unit shall consist of high efficiency paddle type condensate water pump to facilitate forced disposal of condensate water and low gas detection system.

The hi-wall indoor units shall be suitable for installation on the wall preferably at lintel level. The specifications shall otherwise be similar to above.

Ceiling mounted ductable indoor units shall comprise of high static centrifugal fan, direct driven or belt driven through TEFC squirrel cage induction motor suitable for moderate amount of duct work. The housing shall be of light weight construction fabricated out of powder coated galvanized sheet steel single skin panels, internally insulated with 9mm thick closed cell elastomeric insulation material.

b. **Cooling coil**

Cooling coil shall be of the fin and tube type, having aluminium fins, firmly bonded to seamless copper tubes. Face and surface areas shall be such as to assure rated capacity and the air velocity across the coil shall not exceed 170 MPM. The coil shall be factory tested under water at 21 Kg/Sqcm air pressure.

c. **Fan Section**
The fan associated with non ductable indoor units shall be dual suction, aero dynamically designed, multi blade type, statically-dynamically balanced to ensure smooth circulation of air exhibiting lower noise level. The fan shall be direct driven type mounted directly on motor shaft supported from the housing.

Fan associated with ductable indoor unit shall be centrifugal double inlet double width forward curved type, preferably with variable pitch pulleys. The fan housing shall be statically-dynamically balanced at works to ensure noise and vibration free operation.

d. **Filters**

Filters shall be cleanable, synthetic fibre media of approved make. Velocity through filters shall not exceed 105 MPM and pressure drop across filters shall not exceed 5 mm of WG.

e. **Insulation**

All indoor unit shall be factory insulated with minimum 9 mm thick closed cell elastomeric insulation material towards thermal/acoustic treatment.

Drain pan shall be insulated with minimum 9mm mm thick closed cell elastomeric insulation material. Fixing of coil section and drain pan shall be done in such a way to avoid direct metal contact with any other un-insulated metal part in order to avoid condensation.

Condensate drain piping around the indoor unit shall also be insulated with minimum 9mm thick closed cell elastomeric insulation preferably in tubing form.

f. **Refrigerant Piping for Conventional Split Units**

The copper refrigerant piping shall be carried out neatly to connect outdoor and indoor unit/s and shall run along with wires/cables. The refrigerant piping associated with ductable units shall be carried out using hard drawn copper pipes & ready made copper fittings for pipe diameter exceeding 19mm. Piping less than 19mm shall be carried out using soft seamless copper pipes. Joints shall be affected by soldering/brazing process using silver rods. Suitable sleeves shall be provided at all wall crossings as required. The refrigerant circuit shall include liquid line and gas shut-off valves at the end of condenser.

After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using nitrogen at pressure of 21Kg/ Sqcm. Pressure shall be maintained in the system for 24 hours. The system shall then be evacuated to minimum vacuum equivalent to 700mm Hg and held for another 24 hours prior to commencement of gas charging.

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 element by means of inserts or expansion shields of adequate size and number to support the load imposed thereon.
The liquid and suction refrigerant lines including all fittings, valves, strainer etc. shall be insulated with 13 mm thick closed cell elastomeric insulation material preferably in tubing form as specified in Schedule of Quantities.

To protect nitrile rubber insulation associated with exposed copper piping from degrading due to ultra violet rays & atmospheric conditions, it shall be covered with polyshield coating. Fiberglass tape shall be helically wrapped & applied with two coats of resin with hardener to give smooth finish.

g. Electrical Installation

Factory fabricated local control panel shall be provided with each three phase ductable unit. The armoured conductor power cabling along with earthing shall be carried out as required and the cables shall be as per the “Approved Makes”.

3. VOLTAGE STABILIZERS

The stabilizers shall be automatic type of approved make. The stabilizers shall be three step and suitable to convert 140-280V incoming power supply to 200-240V outgoing power supply. Capacities of the stabilizers shall be as reflected in the “Schedule of Quantities”. The stabilizers shall be equipped with the following accessories:

a. Low & high voltage trip.
b. Time delay relay.
c. Ammeter.

4. FILTERS

4.1 Viscous Metallic Filters

Viscous metal filter shall be all metal, washable type. The filter media shall be composed of layers of crimped GI wire mesh. The velocity over face of filter shall not exceed 90 MPM. and pressure drop shall not exceed 5mm for 50mm thick filter. The filter shall be of GI and suitable for mounting as required at site.

4.2 Synthetic Fibre Filters

Synthetic fibre filter shall be cleanable in light weight aluminium framed with non-woven synthetic fibre replaceable media. The filter shall have an efficiency of 90% down to 10 microns when tested as per BS: 2831 standard. It shall be suitable for operation under 100% Relative Humidity & 120 degree C temperature conditions. The velocity over the face of filter shall not exceed 105 MPM and the pressure drop across the filter shall not exceed 2.5mm WG for 25mm thick filter. The filter frame shall be of aluminium and shall be suitable for mounting in air handling unit as required at site.

5. AIR CURTAINS
Air curtains shall be vertical down throw type and shall comprise of twin centrifugal blowers, statically and dynamically balanced, designed for noiseless and continuous operation, motor etc. Necessary documents establishing Dynamic balancing carried out at factory shall be provided with the consignment. The enclosure shall be factory fabricated out of 18 gauge aluminium/CRCA sheet duly powder coated. The outlet shall be carefully designed to create laminar draft providing an invisible air curtain at critical junction isolating clean and semi-clean areas or as required.

6.0 PRECISION PACKAGED UNITS

6.1 Scope

The scope of this section comprises of supply; installation, testing and commissioning of self contained direct expansion type precision air conditioning units suitable for operation on R-410 A refrigerant confirming to ISO 9000/CE norms & should have VDE certification with advanced microprocessor and electronically communicated motors conforming to these specifications and in accordance with the Schedule of Quantities.

6.2 General

Modular construction Precision air conditioning unit suitable for operation on R-410 A refrigerant with bottom discharge arrangement consisting of inlet filter blow through direct drive Electronically commutated Motors and fan, fan motor assembly to deliver below mentioned air quantity, DX Coil, Heater banks to maintain humidity inside the space, condensate drain pan of stainless steel construction, Microprocessor panel, for units with graphical display, programmable control & recording unit complete with intelligent alpha numeric display, function keys, cursor keys, free programmable keys and multi color LEDs. The unit shall be suitable for operation on 415 V 50 Hz AC supply. The Display panel shall display date, time, actual & set values, operating conditions, signal faults, collective faults limiting values. Each unit shall comprise of various sections as listed above & particular specifications capable of delivering Actual cooling capacity as specified in Schedule of Quantities and must be equipped with Scroll compressor/s, blower and motor assembly, heater banks, humidifier, electronic expansion valve. Microprocessor preferably to consist of dual set point for programming with RS 485 communication port & communication with Modbus RTU protocol for hookup to BMS/BAS for monitoring of all parameters. Microprocessor to be suitable to shoot SMS to designated Mobile Phones incase of any alarm.

6.3 Unit Base & Casing

Base panel shall be constructed out of 1.2 mm Zinc-anneal corrosion resistant sheet steel structure of adequate size. The exterior casing panels shall be constructed out of 1.2mm thick galvanized steel sheet and provided with minimum 25mm thick Fiber glass/mineral wool insulation sandwiched in between. The cabinet shall be powder coated to have a smooth finish. Casing panels shall be of welded construction, removable type to provide easy access to equipment and shall be bonderised and painted. Casing shall be complete with space for refrigeration equipment, fans, cooling coils and strip heaters besides factory fabricated supply air plenum and discharge outlets.
Unit shall be provided with welded tubular steel floor stand with adjustable legs and requisite vibration isolation pads. Unit casing shall be thermally and acoustically lined with 25 mm thick, 32 Kg/ CuM density environmental friendly mineral wool (fibre glass) insulation material.

6.4 Fan

The unit shall be fitted with direct-driven, high efficiency, single inlet, backward curved, centrifugal ‘plug’ type fan/s, with aluminium nozzle/s and impeller/s. The fan motors shall be Electronically Commutated (EC), true soft start characteristics (inrush current lower than operating current), IP54, with internal protection, thermal protection and speed regulation via controller signal. The fans shall be statically and dynamically balanced. The fan outlet velocity shall not exceed 300 MPM.

The fan speed must be controlled based on the room return air temperatures and shall have automatic speed control without manual intervention. Use of automatic transformer for speed control shall not be acceptable. Also during dehumidification mode the controller must give an output to the fans to operate at lower speeds thus reducing the airflow and enhancing the latent cooling capacity of the units.

Units shall be factory balanced in accordance with Section 15071, Mechanical Sound And Vibration Control.

Fan curves showing operating parameters to be attached with quote also indicate model of fan.

6.5 Filters

Filters shall be cleanable, replaceable, synthetic fibre media of approved make having efficiency 95% down to 5 microns. Velocity through filters shall not exceed 120 MPM and pressure drop through filters shall not exceed 5mm of WG.

6.6 Cooling coil

Precision unit shall comprise of direct expansion cooling coil of copper tubes expanded into aluminium fins, firmly bonded. Face and surface areas shall be such as to assure rated capacity and the air velocity across the coil shall not exceed 140 MPM. The cooling coil shall be minimum of 3 rows deep and the fin spacing shall not exceed 1.8mm.

Coil selection to be suitable for SHF > 0.95 and provided with hydrophilic coating to minimize / eliminate water carry over into the airflow stream.

SS Drain pan shall be factory insulated with atleast 9mm thick closed cell elastomeric insulation, joints sealed with self adhesive tape of same material. Fixing of coil section and drain pan shall be done in such a way to avoid direct metal contact with any other un-insulated metal part in order to avoid condensation.

Drain piping and refrigerant piping within the unit shall be insulated with atleast 9mm thick closed cell elastomeric insulation in tubing form.

6.7 Condenser
Condenser shall be air-cooled type, suitable for outdoor installation and shall be suitable for operating at 44 deg C db and 24 deg C wb temperatures. Condenser shall be in copper tube & aluminium fins construction. Condenser coil shall be of minimum 4 rows deep and the fin spacing shall not exceed 2mm. The maximum face velocity across the coil shall not exceed 215 MPM. The condenser frame shall be constructed from heavy duty galvanized steel. The condenser shall be constructed from heavy duty aluminum and corrosion resistant through special anti corrosive epoxy coatings for any specific polluted areas as required. Heavy duty mounting legs and all assembly hardware shall be included. Condensers shall be suitable for 24 hours operation and be capable of providing vertical or horizontal discharge.

The condenser fan/s shall be of propeller type with 900 RPM variable voltage electric motor complete with IP-55 protection. Motor shall be speed controlled to ensure a stable operation for varying ambient, by a factory fitted direct acting head pressure activated variable speed drive. The condenser shall be complete with provisions for refrigerant piping connections, shut off valves and any other standard accessories necessary with the equipment supplied.

**Anti-corrosion Treatment**

The condenser should be designed with anti-corrosion specifications as detailed below for use in area, which are subject to salt damage and atmospheric pollution as specified in the BOQ.

The portion of machines like side panel, outer panel, bottom frame, which are exposed to corrosive atmosphere, should be of alloyed hot-dip zinc coated steel plate, coated with corrosion protection powder polyester resin coating on both inner and outer surfaces in thickness of 64 micron or more.

Finned coil protection net should have coating of resin coating containing ultraviolet ray absorbent. Fan and its fan protective net should be with weather resistant polypropylene resin.

The copper pipe –aluminium fins shall be special acrylic resin coated and internal supports, frame, control box shall also be hot-dip zinc coated steel plate and with rust preventive powder coating of 64 micron or more on inner and outer surfaces.

All screws and bolts used in outdoor unit shall be provided with SUS410, Zinc-nickel alloy plating, zinc chrome acid film treatment and rust inhibitor coating.

**6.8 Electric Strip heaters**

Each packaged unit shall be provided with electric strip heaters/tubular heaters with multi step heaters with multi stage heating thermostat having minimum of two steps of heaters with two stage heating thermostat. Electric strip heaters shall be of the low temperature totally enclosed strip type fitted with radiation fins and suitable for operating at black heat. The sheath shall be completely sealed against the entry of moisture. The heater bank shall be arranged to ensure an even temperature distribution across the air stream and shall be readily removable as a unit. The terminal ends of the heating element sheathings shall pass through the casing of the unit to a terminal box mounted on the casing. The element sheathing shall be fitted with screwed bushes where they pass through the casing and the joints shall be sealed with gaskets and nuts on both sides.

Supply and install (or paint) on the exterior of the unit in a prominent position adjacent to the heater bank a notice, which shall read.
FIRE

This unit contains electric heating elements and is fire resistant. In the event of fire, disconnect the power by the main isolating switch.

(Characters to be in white, 15mm high for the word “FIRE” and 5mm high for the rest on a red background)

Necessary hardware & software for BMS Integration should be part of supply.

Following additional accessories should also be part of scope:

a) Raised Floor Stand suitable for 600 mm high
b) BMS Integration Software. (Modbus RTU protocol)
c) Connection to tele monitoring-system (optional)
d) Bridge type Water Detector for an length of 2 M length
e) Antifreeze Switch (optional)
f) Steam Humidifier of requisite capacity
g) Multistage Electrical Heaters of suitable capacity
h) Non Return Valve on the liquid line
i) Solenoid Valves for Dehumidification
j) Regulating Valves
k) EC motors plug speed control is mandatory.

6.9 Humidifier

Boiling water in a polypropylene steam generator shall provide humidification. The steam shall be distributed evenly into the bypass air stream of the precision air conditioning unit. The humidifier shall be capable of providing 10-15 Kg of steam per hour or as per system requirement. The humidifier shall have an efficiency of not less than 1.3 Kg per KW and be fitted with an auto flush cycle activated on demand from the unit's control system. The power consumption of humidifier shall not exceed 0.73 KW/Kg.

The humidifier shall be fully serviceable with replaceable electrodes. Waste water shall be flushed from the humidifier by initiation of water supply solenoid valve via U-trap.

6.10 Water Sensor:

The system shall be provided with relevant water detection kit which shall have minimum of 3 sensors per kit, the wire must have a length of minimum 2 mtrs and each of the sensor must be capable to detect individually any water below the false floor near the unit, the sensor must be connected to the unit microprocessor thus enabling the controller to give an alarm incase of wet floor. Necessary cabling between unit controller and sensor to be included under part of scope with unit supply.

6.11 Microprocessor Control System

Each unit to be provided with independent master controller with graphical display.
Logic Circuitry:

A microprocessor shall continuously monitor operation of TOC Room/Lab air-conditioning unit continuously digitally display room temperature and room relative humidity, sound alarm on system malfunction and simultaneously display problem. When more than one malfunction occurs, flash fault in sequence with room temperature, remember alarm even when malfunction cleared, and continue to flash fault until reset.

Malfunctions:

Power Loss, Loss of Airflow, Clogged Air Filter, High Room Temperature, Low Room Temperature, High Humidity, Low Humidity, Supply Fan Overload, and Water under Floor / Fire alarm.

Light Emitting Diodes Display:

Control Power On, System On, Humidification, and Dehumidification taking place. Provide push buttons, SILENCE audible alarm, push-to-test LED indicators, and display room relative humidity.

Automatic lead unit sequencing to extend equipment life and automatic rotation of standby unit. Dual set point for temperature must be provided. Microprocessor must be suitable to control multiple units if required with hard wiring which can be done at a later date.

Microprocessor must operate on 24 V supply from step down transformer provided in electric panel of the unit. Each unit microprocessor to have independent display for Room Temperature / Humidity, Alarm indication, operating status.

Microprocessor must provide information on runtime of each compressor / heater / humidifier etc.

Automatic changeover to standby unit on malfunction of one of units running.

Microprocessor panel should be possible to hook up to the Centralized BM system. Necessary integration card for integration to be included in the scope of work including inter connecting wiring if required for integration. It should be possible to hook up to 10 units. All the information available on the microprocessor graphic screen should be able to transfer to BMS system. In case of power failure the precision packaged unit shall start automatically without any body’s intervention.

The Microprocessor must have inbuilt logic to automatically control the speed of the Electronically communicated Motors based on the return or supply air conditions.

The Microprocessor must also have Filter Management program by which the controller will increase the fan speeds incase of a clogged filter condition thus preventing frosting at point of time and also to avoid deration in the cooling capacity of the unit due to reduced airflow.

6.12 Floor plenum pressurisation system
False floor can be equipped with pressure sensors at required locations. PL Controller can sense the pressure and convey signal to PLC to regulate the air flow from Precision AC units. This is required for energy conservation.

6.13 Scroll Compressor

The scroll compressor shall be an industrial quality rugged, cast iron, direct hermatic compressor with scroll plates, suction & discharge service valves. The compressor shall be complete with straight suction tube, centrifugal oil pump, oil charging valve, oil level sight glass, crank case heater and check valve on the scroll discharge port. The compressor shall be complete with the provision of two-point lubrication for each motor bearing. The compressor shall be completely enclosed in a chamber with no leakage path and providing the capability for scroll plates to separate. The compressor shall be provided with industrial solid motor mounts internal motor protection and vibration isolation pads. Each compressor shall be independently wired and piped to its own circuit for efficient operation & ease of maintenance. The compressor speed shall not exceed 3000 RPM.

6.14 Refrigerant Piping

The copper refrigerant piping shall be carried out neatly to connect remote air cooled condensers and indoor precision unit and shall be concealed in plastic conduit along with wires/cables. Suitable sleeves shall be provided at all wall crossings as required. The suction line and condensate drain piping shall be insulated with minimum 13mm thick closed cell elastomeric insulation in tubing form in continuity terminating at the nearest drain point. Floor drain arrangements shall be provided by other agencies in conformity with the approved for construction shop drawing.

6.15 Installation and Commissioning

a) Install units in accordance with manufacturer’s instructions.
b) Coordinate installation and final elevation of Server Room air-conditioning units with Server Room raised floor installer.
c) Provide adequate drainage connections for condensate and humidifier flushing system.
d) Pipe work shall not be stacked and shall run parallel to airflow wherever possible.

Field Quality Control

Manufacturer’s Startup Services:

A manufacturer’s representative for the Server room air-conditioning units shall be deputed as necessary to assist the HVAC executing agency during installation, and to provide written certification that the equipment has been installed, complete as specified and in accordance with the manufacturer’s directions as approved.

The manufacturer’s service representative shall provide initial prestart and startup of the equipment as per check list.

Log and record all information from every test, reading, and adjustment necessary to accomplish the services described and submit to Contractor for review.
Note: Specifications for Hi Sensible Units shall remain same as above except the change that Hi Sensible Units shall have no Heaters & Humidifiers.

B. "SPECIFICATIONS - VENTILATION FANS"

1. CENTRIFUGAL FANS

1.1 Centrifugal fans shall be of approved make DIDW or SISW of specified arrangement complete with inspection door, squirrel-cage induction motor, V belt drive, belt guard and vibration isolators etc. Type, direction of discharge / rotation, and motor position shall be as per the Approved for Construction shop drawings.

1.2 Fans, Aerofoil, forward or backward curved, SISW or DIDW shall be licensed to bear the AMCA Air and Sound Certified Ratings Seal. The test standard used shall be ANSI/AMCA 210-85, ANSI/ASHRAE Standard 51-1985 “Laboratory Method of Testing Fans for Rating” and AMCA 300 “Reverberant Room Method for Sound Testing of fans”.

1.3 All fans shall be dynamically trim-balanced to ISO1940 and AMCA 204/3 - G2.5 quality grade after assembly. A computer printout with vibration spectrum analysis shall be attached to the fans.

1.4 All fans shall be oven-baked with polyester coating for minimum thickness of 60 microns unless the housing scroll and side frame is constructed from galvanized steel sheet (GSS). Fan should be of G.S.S., the Steel sheet should be JFE Galvazinc (Base metal cold rolled), JIS G3302, SGCC with Z22 (minimum coating weight on both sides @ 220 g/m2) zinc coating & Zero Spangle, skin passed, chromated and dry.

1.5 Fans housing shall be of an appropriate thickness to prevent vibration and drumming and in no case the housing shall be constructed less than 14 Gauge sheet steel and all parts
shall be bonderized and then coated with primer finish of approved colour. The fan scroll shall be attached to the side plate by means of continuous lock seam or welded seams. 18 gauge galvanized wire mesh inlet guards of 5 cm sieves shall be provided on both inlets. Housing shall be provided with standard cleanout and door with quick locking tension handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.

The wheel and inlet cone shall be aerodynamically designed and constructed to provide maximum performance and efficiency as published by the manufacturer.

1.6 Fans must be physically capable of operating safely at every point of rating at or below the “minimum performance” limit for that class as defined in AMCA standard 99-2408-69 “Performance Class of Operating Limits for Centrifugal Fans”.

1.7 Shafts sizes shall be carefully calculated and designed such that the maximum operating speed (RPM) shall not exceed 75% of the first critical speed. For any application that is not a standard product from catalogue of the fan manufacturer detailed calculation of critical speed characteristic shall be submitted for approval.

1.8 Shafts shall be constructed out of carbon steel (C45) machined and polished to tolerance of standard ISO 286-2 - grade g6. Protective coat of anti-rusting shall be applied to all bare surfaces of the shafts at the factory.

1.9 Bearings shall be of self-alignment (concentric) type with adaptor sleeve bearing. Bearings of eccentric locking collar with grub screw type are not acceptable. Bearing shall be maintenance free with permanently lubricated sealed ball bearing type. Bearing life shall be at least 75,000 hours based on basic rating life, L10 of ISO 281 standard. Calculation sheet of Bearing Life shall be submitted for approval.

1.10 Motor installed shall be of a minimum 130% of the fan power absorbed (Brake horsepower) and shall have sufficient torque available for starting and continuous operation. Motor shall be suitable for 415 ± 10% volts, 50 Hz, 3 phase power supply.

1.11 Belts and pulleys shall be sized for a minimum 150% of the installed motor horsepower. The belt speed shall not exceed 30m/s. The pulley shall be of Taper Lock SPZ, SPA, SPB or SPC type. Conventional type of pulley is not acceptable. Both fan and motor pulley shall be balanced to the quality grade G.2.5.

1.12 Fan outlet velocity shall not exceed 2000 FPM (10.16 MPS) and maximum fan speed shall be 1000 RPM. Fan wheel and housing shall be statically and dynamically balanced. Necessary documents establishing Dynamic balancing carried out at factory shall be provided with the consignment.

1.13 Computer printout on fan performance rating corresponding to the AMCA licensed data, with corrected rating for altitude and temperature, fan operating speed, bearing life, etc. shall be submitted for approval.

1.14 For Air washer Application, fans should be provided with coat of Pure polyester powder coating. Fans should have Inspection door & Drain plug.

2. **Propeller Type Fans:**
The propeller type fans shall be used for exhaust air or for fresh air supply as shown on the drawings having following constructional features:

a. Fans shall be of ring mounted type having steel hub and MS blade, mounted directly on the shaft of a totally enclosed motor. Bearings shall be maintenance free permanently lubricated type.

b. The fan blades shall be constructed out of pressed steel in aerofoil design to achieve high efficiency. The mounting frame shall be of cast/sheet steel with steel brackets to connect the frame with the fan/motor assembly.

c. Rubber mounts shall be provided between the mounting frame and the mounting brackets. The fan shall be direct driven type and motor shall either be capacitor start–run or three phase squirrel cage induction type totally enclosed.

d. The fan shall be fitted with gravity type louvers. The speed of fan shall be as mentioned in “Bill of Quantities” and drawings.

e. All the fans shall be tested for performance and the following test results shall be furnished:

   i. Air flow rate in C.F.M.
   ii. Static pressure at the fan supply end.

3. Inline Fans:

The inline fans shall be used for exhaust air or for fresh air supply as shown on the drawings having following constructional features:

a. The casing shall be constructed out of hot rolled heavy gauge GSS metal epoxy coated embodied with required inspection doors.

b. Fan shall be direct driven SISW forward or backward curved centrifugal type. Material of construction for impeller shall GSS. Fan wheel shall be statically and dynamically balanced.

c. The bearing shall be completely maintenance free and can be used in any mounting position, at maximum indicated temperature.

d. Motor shall be total enclosed external rotor type and suitable for operation on 415±10% volts, 3phase or 220±6% volts, 1 phase, 50Hz AC power supply.

e. Single phase inline fans shall be provided with factory fitted speed regulators and three phase inline fans shall be provided with GI dampers.

f. All the fans shall be tested for performance and the following test results shall be furnished:

   i. Air flow rate in C.F.M.
   ii. Static pressure at the fan supply end.
C.  “SPECIFICATIONS - PIPING”

1. **General:**
   
   a. The scope under this section covers supply, laying, erection, testing and commissioning of pipes, pipe fittings and associated valves conforming to these specifications and the general arrangements shown on the drawings.

   b. All piping including pipe fittings and valves shall follow the relevant Indian Standards/manufacturer’s recommendations.

2. **Refrigerant Piping:**

   All refrigerant piping for the VRV air conditioning system shall be constructed out of hard drawn copper refrigerant pipes with copper fittings and silver-soldered joints. The refrigerant piping arrangements shall be in accordance with good engineering practice within the air-conditioning industry, and shall be inclusive of charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits.

   All joints in copper piping shall be sweet joints using low temperature brazing and or silver solder. Before jointing 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.

   The Refnet Joints (Y-joints) and Refnet Headers shall be made from copper and would be imported, factory fabricated and pre-insulated.

   After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using nitrogen at pressure of 35Kg/Sq. Cm and 10 Kg/Sq.Cm (low side). Pressure shall be maintained in the system for 24 hours. The system shall then be evacuated to minimum vacuum of 700mm Hg and held for 24 hours.

   The air-conditioning system supplier shall verify the refrigerant piping design conceived and brought to the notice of Consultants if any discrepancy is found.

   The OD & wall thickness of copper refrigerant piping shall be as follows:

<table>
<thead>
<tr>
<th>Outside Pipe Dia (mm)</th>
<th>Wall thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>54.1</td>
<td>1.5</td>
</tr>
<tr>
<td>41.3</td>
<td>1.3</td>
</tr>
<tr>
<td>34.9</td>
<td>1.3</td>
</tr>
<tr>
<td>28.6</td>
<td>1.2</td>
</tr>
<tr>
<td>25.4</td>
<td>1.2</td>
</tr>
<tr>
<td>22.2</td>
<td>1.2</td>
</tr>
<tr>
<td>19.1</td>
<td>1.0</td>
</tr>
<tr>
<td>15.9</td>
<td>1.0</td>
</tr>
<tr>
<td>12.7</td>
<td>0.8</td>
</tr>
<tr>
<td>Outside Pipe Dia (mm)</td>
<td>Wall thickness (mm)</td>
</tr>
<tr>
<td>----------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>9.5</td>
<td>0.8</td>
</tr>
<tr>
<td>6.4</td>
<td>0.8</td>
</tr>
</tbody>
</table>

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.

The whole of the liquid and suction refrigerant lines including all fittings, valves and strainer bodies, etc. shall be insulated with 19mm thick closed cell elastomeric insulation material.

The joints shall be properly sealed with synthetic glue to ensure proper bonding of the ends.

3. **Drain Piping:**
   a. All pipes to be used for drain, condensate drain and fittings shall be galvanized steel class ‘B’ (medium class) confirming to relevant IS & BIS Codes.
   b. All jointing in the pipe system shall be by screwed and / or by screwed flanges using 3mm 3 ply rubber insertion gaskets. Pipe threads and flanges shall be as per relevant BIS Codes.
   c. All pipes supports shall be mild steel, thoroughly cleaned and given one primary coat of red oxide paint before being installed.
   d. Fittings shall be galvanized steel “medium class” malleable casting of pressure rating suitable for the piping system. Flanges shall be of approved make. Supply of flanges shall include bolts, nuts, and gaskets as required. Sufficient number of flanges and unions shall be provided for future cleaning and servicing of piping. Tee-off connection shall be through equal or reducing Tees. All equipment and valve connections or connections to any other mating pipes shall be through flanges required for the mating connections.
   c. All condensate drain piping shall be insulated with closed cell elastomeric insulation material of thickness as mentioned in “Schedule of Quantities”.

4. **Insulation**

Drain Pipes shall be insulated as required or as shown on the approved drawings and in line with specifications stipulated in section ‘INSULATION’.

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D. **“SPECIFICATIONS - DUCTWORK AND AIR TERMINALS”**

1. **General:**
a. The scope under this section covers supply, fabrication, installation and testing of all GS sheet metal ducts and supply, installation, testing and balancing of grilles, diffusers conforming to these specifications and the general arrangements shown on the tender drawings.

b. Duct work shall mean all ducts, dampers, access doors, joints, stiffeners, supports and hangers.

2. **Duct Work Fabricated at Site as per BIS Standards**

2.1 **Duct Material and Fabrication**

Material used for ducts shall be galvanized steel sheets class VIII conforming to IS:277-1962(revised) or aluminium sheets conforming to IS:737-1955 as specified in the Bill of Quantities. All ducts shall be fabricated and installed in a workman like manner, generally conforming to IS : 655-1963 (Revised) with amendment- I(1971 edition). Fabrication of ducts shall be through well conditioned Triplex lock former or multiple lock formers, conforming to relevant BIS Codes. Round exposed ducts shall be die formed for achieving perfect circle configuration.

Thickness of the sheet shall be as given hereunder:

<table>
<thead>
<tr>
<th>Size of Duct</th>
<th>GSS</th>
<th>Aluminium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 750 mm</td>
<td>24 Gauge (0.63mm)</td>
<td>22 Gauge (0.80mm)</td>
</tr>
<tr>
<td>751 mm to 1500 mm</td>
<td>22 Gauge (0.80mm)</td>
<td>20 Gauge (1.00mm)</td>
</tr>
<tr>
<td>1501 mm to 2250 mm</td>
<td>20 Gauge (1.00mm)</td>
<td>18 Gauge (1.25mm)</td>
</tr>
<tr>
<td>2251 mm and above</td>
<td>18 Gauge (1.25mm)</td>
<td>16 Gauge (1.6mm)</td>
</tr>
<tr>
<td>All Round Ducts</td>
<td>20 Gauge (1.00mm)</td>
<td>--</td>
</tr>
</tbody>
</table>

Joints and bracing of ductwork shall generally be as per IS Specifications. However, minimum size of accessories involved shall be as given hereunder:

<table>
<thead>
<tr>
<th>Size of Duct</th>
<th>Joint Type</th>
<th>Bracing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 750 mm</td>
<td>G.I. Flange</td>
<td>--</td>
</tr>
<tr>
<td>751 mm to 1000 mm</td>
<td>25 mm x 25 mm x 3 mm angle iron frame with 8 mm dia nuts and bolts.</td>
<td>25 mm x 25 mm x 3 mm angle iron frame at 1000 mm centre</td>
</tr>
<tr>
<td>1001 mm to 1500 mm</td>
<td>40 mm x 40 mm x 5 mm angle iron frame with</td>
<td>40 mm x 40 mm x 3 mm angle iron frame at 1000 mm centre</td>
</tr>
<tr>
<td>Measurement Range</td>
<td>Iron Frame Details</td>
<td>Cotter and Bolts</td>
</tr>
<tr>
<td>---------------------------</td>
<td>------------------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>1001 mm to 1500 mm</td>
<td>40 mm x 40 mm x 5 mm angle iron frame with 8 mm dia nuts and bolts.</td>
<td>40 mm x 40 mm x 3 mm angle iron frame at 1000 mm centre</td>
</tr>
<tr>
<td>1501 mm to 2250 mm</td>
<td>50 mm x 50 mm x 5 mm angle iron frame with 12 mm dia nuts and bolts. at 125 mm centre.</td>
<td>40 mm x 40 mm x 3 mm angle iron frame at 1200 mm centre (diagonally cross braced)</td>
</tr>
<tr>
<td>2251 mm and above</td>
<td>50 mm x 50 mm x 6 mm angle iron frame with 12 mm dia nuts and bolts. at 125 mm centre.</td>
<td>40 mm x 40 mm x 3 mm angle iron frame at 1200 mm centre (diagonally cross braced)</td>
</tr>
</tbody>
</table>

2.1.2 GI sheets shall be produced using hot deep galvanization process and minimum acceptable coating of zinc shall be 120gm/SqM. Sample of GI sheet along with test certificate to be submitted for approval prior to supply of GI sheets.

2.1.3 GI sheets shall be checked for hardness/flexibility and water marks prior to dispatch. Zinc coating if found peeled –off or duct work with water marks after fabrication shall be rejected.

2.1.4 Ducts shall be straight and smooth on the inside with neatly finished joints. All joints shall be made air tight.

2.1.5 All exposed ducts within conditioned spaces shall have only slip joints and no flanged joints. The internal ends of slip joints shall be made in the direction of air flow.

2.1.6 Change in dimensions and shape of ducts shall be gradual. Curved elbows, unless otherwise approved, shall have a centre line radius equal to one and half times the width of the duct. Air turns shall be installed in all abrupt elbows and shall consist of curved metal blades or vanes, arranged to permit the air to make the turns without appreciable turbulence.

2.1.7 GI splitter dampers complete with brass metal lever shall be installed at each bifurcation / trifurcation point of duct for proper flow of air quantity in each duct.

2.1.8 Ductwork shall be fabricated strictly in accordance with the “Approved for Construction” Shop drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees or angles of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.

2.1.9 All sheet metal connections, partitions and plenums required to confine the flow of air to and through the filters and fans, shall be constructed out of 18 gauge galvanized steel sheet, thoroughly stiffened with angle iron braces mentioned above and fitted with all necessary doors as required by the Consultants, to give access to all parts of the apparatus. Doors shall not be less than 45cm x 45cm in size. All hardware fittings such as thunder bolts, hinges, handles etc shall be in extruded aluminium construction.
2.2 **Installation of Ductwork**

2.2.1 During construction, the contractor shall temporarily close the duct openings with sheet metal covers to prevent debris and any foreign material entering ducts and to maintain opening straight and square.

2.2.2 All ducts shall be installed generally as per the drawings and in strict accordance with approved shop drawings to be prepared by the contractor.

2.2.3 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. This work shall meet with the approval of the Architects/Owners in all its parts and details.

2.2.4 All ducts shall be supported from the ceiling/slab using 9mm to 12mm dia MS rods depending upon the size of the duct unless & until mentioned otherwise in the BOQ. MS angle iron of size not less than 40mmx40mmx5mm or more if duct size is large enough shall be used at the bottom. The MS rods shall be anchored to RCC slab using suitable metallic expansion fasteners.

2.2.5 All necessary allowances and provisions shall be made by the contractor for beams, pipes or other obstructions in the buildings, whether or not the same are shown on the drawings. Where it becomes 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 as approved or directed by the Architects/Consulting Engineer.

2.2.6 If a duct cannot be run as shown on the drawing, the contractor shall install the duct between the required points by any path available, subject to the approval of the Architect/Consultant.

2.2.7 All duct work shall be independently supported from building elements or as required by the Architect/Consultant. All horizontal ducts shall be rigidly and securely supported, in an approved manner, within hangers formed of MS rods and angle iron under ducts not greater than 2 M centers. All vertical duct work shall be supported by structural members at each floor.

2.2.8 Ducting on top of the ceiling shall be supported from the slab above, or from beams with the help of adequate strength dash fasteners, after obtaining approval of the Architect/Consultant. In no case shall a duct be supported from the ceiling hangers or be permitted to rest on a hung ceiling.

2.2.9 All metal work in dead or closed down spaces shall be erected in time to occasion no delay to other contractors in the building.

2.2.10 All air turns of 45 degrees or more shall include curved metal blades or vanes so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration. All supply air collars shall be provided with GI vanes properly secured using rivets.
2.2.11 All ducts shall be totally free from vibration under all conditions of operations. Whenever duct work is connected to fans, that may cause vibrations in the duct, ducts shall be provided with two flexible connections located close to the unit in mutually perpendicular directions. Flexible connection shall be constructed of fire resistant flexible double canvas sleeves at least 150mm long, secured properly and bolted at both ends. 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.

2.2.12 The two mating flanges of the ducts being joined with each other shall be made air tight by providing 4mm thick rubber gasket fixed on both mating flanges by means of good quality adhesive. Rubber strip shall also be provided between bottom surface of duct and angle iron at each duct support to avoid metal to metal contact.

2.2.13 All duct supports including MS rods, cleats and angle iron shall be primer coated and thereafter, painted with black enamel paint.

2.3 Round Ductwork

Spiral/round ductwork wherever required shall meet following parameters :

a. Conform to BIS round ductwork requirements.

b. Round Ducts shall be constructed out of galvanized sheet steel as per relevant BIS standards.

c. Upto 1200mm dia ducts spiral lock seam shall be provided.

d. Ducts more than 1200 mm diameter shall be provided with welded longitudinal or spiral seam.

e. Lap or snap lock seams are not permitted for round ductwork of any size.

f. Provide beaded sleeve or flanged and gasketed joints for ducts.

g. Provide all welded long radius elbows.

h. Provide conical tees, all welded.

i. Butt tees or butt taps are not permitted.

All round ducts, 750 mm and larger, shall be supported with two hangers at each support point in an approved manner.

3. Duct Work Fabricated in Factory as per SMACNA Standards

3.1 Duct Material and Fabrication

Material used for ducts shall be galvanized steel sheets class VIII, light coating of zinc, nominal 120gm/SqM surface area conforming to IS:277-1962 (revised) or aluminium sheets conforming
to IS:737-1955 as specified in the Bill of Quantities. GI sheet shall be of Lock Forming Quality prime material along with mill test certificates. In addition, if deemed necessary, samples of raw material, selected at random by Client’s site representative shall be subject to approval and tested for thickness and zinc coating at contractor’s expense.

3.2. Recommended Thickness and Type of Joints

All ducts shall be fabricated using galvanized steel/aluminum sheet with thickness as mentioned hereunder:

3.2.1 For Ducts with External Static Pressure (SP) upto 250 Pa (25mm):

<table>
<thead>
<tr>
<th>GSS Rectangular Ducts</th>
<th>Pressure 250 Pa (25mm)</th>
<th>Duct Section Length 1.2 m (4 ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum Duct Size</strong></td>
<td><strong>Gauge as per BOQ</strong></td>
<td><strong>Joint Type</strong></td>
</tr>
<tr>
<td>1–750 mm</td>
<td>26 or 24</td>
<td>“4 Bolt Transverse Duct Connector-E (TDC) with built in sealant” as per BOQ.</td>
</tr>
<tr>
<td>751 – 899 mm</td>
<td>24</td>
<td>4 Bolt Transverse Duct Connector-E (TDC) with built in sealant</td>
</tr>
<tr>
<td>900 – 1200 mm</td>
<td>24 or 22</td>
<td>4 Bolt TDC –E</td>
</tr>
<tr>
<td>1201 – 1500 mm</td>
<td>22</td>
<td>4 Bolt TDC-H</td>
</tr>
<tr>
<td>1501 – 1800 mm</td>
<td>22 or 20</td>
<td>4 Bolt TDC-H</td>
</tr>
<tr>
<td>1801 – 2100 mm</td>
<td>20</td>
<td>4 Bolt TDC-J</td>
</tr>
<tr>
<td>2101 – 2700 mm</td>
<td>18</td>
<td>4 Bolt TDC-J</td>
</tr>
</tbody>
</table>

3.2.2 For Ducts with External Static Pressure (SP) up to 500 Pa (50mm):

<table>
<thead>
<tr>
<th>GSS Rectangular Ducts</th>
<th>External Pressure 500 Pa (50mm)</th>
<th>Duct Section Length 1.2 m (4 ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum Duct Size</strong></td>
<td><strong>Gauge</strong></td>
<td><strong>Joint Type</strong></td>
</tr>
<tr>
<td>1–600 mm</td>
<td>24</td>
<td>“4 Bolt Transverse Duct Connector-E (TDC) with built in sealant” as per BOQ.</td>
</tr>
<tr>
<td>601-700 mm</td>
<td>24</td>
<td>4 Bolt Transverse Duct Connector-E (TDC) with built in sealant</td>
</tr>
<tr>
<td>701-900 mm</td>
<td>24 or 22</td>
<td>4 Bolt TDC-E</td>
</tr>
<tr>
<td>901-1200 mm</td>
<td>22 or 20</td>
<td>4 Bolt TDC-H</td>
</tr>
<tr>
<td>Diameter (mm)</td>
<td>Length (mm)</td>
<td>Bolt Size</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
<td>-----------</td>
</tr>
<tr>
<td>1201-1300</td>
<td>20</td>
<td>4 Bolt TDC-J</td>
</tr>
<tr>
<td>1301-1500</td>
<td>18</td>
<td>4 Bolt TDC-J</td>
</tr>
<tr>
<td>1501-1800</td>
<td>18</td>
<td>4 Bolt TDC-J</td>
</tr>
<tr>
<td>1801-2100</td>
<td>18</td>
<td>4 Bolt TDC-J</td>
</tr>
<tr>
<td>2101-2250</td>
<td>18</td>
<td>4 Bolt TDC-J</td>
</tr>
<tr>
<td>2251-2400</td>
<td>18</td>
<td>4 Bolt TDC-J</td>
</tr>
<tr>
<td>2401-2700</td>
<td>18</td>
<td>4 Bolt TDC-J</td>
</tr>
</tbody>
</table>

'C'-cleat; 'S'-S cleat; 'SS'-Standing S cleat; 'AI'-Angle Iron in mm
* Distance of reinforcement/bracing from each joint. Bracing material to be same as of material used for joining of duct sections.

For Aluminium ducts material shall be one commercial gauge higher with 22 gauge as minimum.

3.3 Fabrication Standards and Equipment

All duct construction and installation shall be in accordance with SMACNA standards. In addition ducts shall be factory fabricated utilizing the following machines to provide the requisite quality of ducts.

3.3.1 Coil (Sheet metal in Roll Form) lines to facilitate location of longitudinal seams at corners/folded edges only, for required duct rigidity and leakage free characteristics. No longitudinal seams permitted along any face side of the duct.

3.3.2 All ducts, transformation pieces and fittings to be made on CNC profile cutter for requisite accuracy of dimensions, location and dimensions of notches at the folding lines.

3.3.3 All edges to be machine treated using lock formers, flangers and rollers for turning up edges.

3.4 Duct Construction

All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA codes.

a) Ducts so identified on the Drawings shall be acoustically lined and insulated from outside 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. The fabricated duct dimensions should be as per approved drawings and care should be taken to ensure that all connecting sections are dimensionally matched to avoid any gaps.
b) Ducts shall be straight and smooth on the inside with longitudinal seams shall be airtight and at corners only which shall be either Pittsburgh or snap button as per SMACNA practice, to ensure air tightness.

c) All concealed ducts up to 750mm width within conditioned spaces shall have slip and drive (C & S/SS) joints. The internal ends of slip joints shall be in the direction of airflow. Care should be taken to ensure that S/SS Cleats are mounted on the longer side of the duct and Cleats on the shorter side. Ducts and accessories within ceiling spaces, visible from air-conditioned areas shall be provided with two coats of mat black finish paint.

d) Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Air-turns (vanes) shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.

e) Ducts shall be fabricated as per details shown on Approved for Construction Shop Drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.

f) All sheet metal connection, partitions and plenums, required to confine the flow of air to and through the filters and fans, shall be constructed of 18 gauge GSS / 16gauge aluminum, thoroughly stiffened with 25mm x 25mm x 3mm galvanized steel angle braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Access doors shall be not less than 450mm x 450mm in size.

g) Plenums shall be shop/factory fabricated panel type and assembled at site. Fixing of galvanized angle flanges on duct pieces shall be with rivets heads inside i.e. towards GS sheet and riveting shall be done from outside.

h) Self adhesive Neoprene rubber / UV resistant PVC foam lining 5mm nominal thickness instead of felt, shall be used between duct flanges and between duct supports in all ducting installation.

3.5 Duct Installation

All ducts shall be installed generally as per tender Drawings, and in strict accordance with approved shop drawings to be prepared by the Contractor. The contractor shall also carry out the feasibility study at site, coordination with other services and interior drawings before fabrication of duct at the factory. Any fabricated duct rejected due to these reasons shall not be paid and only final measured and installed duct shall be certified for payment.

a. 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 Architects/Consultants/Client’s site representative in all its parts and details.

b. 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 conduits, the ducts shall be transformed, divided or curved to one side (the required area being maintained) all as per the site requirements.

c. 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 Client’s site representative. Fabrication of duct shall be commenced only after verifying the feasibility at site.

d. All duct work shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze hangers formed of fully threaded galvanized steel rods and galvanized steel angle/channel under ducts at no greater than 2 meter centre. All vertical duct work shall be supported by structural members on each floor slab. Galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods and angles/channels shall be hung through these cleats. Duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Hanger rods shall then hang through the cleats. Size of supports shall be as given hereunder:

<table>
<thead>
<tr>
<th>Larger Size of Duct</th>
<th>“C” channel size</th>
<th>Fully threaded GI Vertical Rod size</th>
<th>Maximum spacing between supports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 600mm</td>
<td>40mmx40mmx18gauge</td>
<td>8mm</td>
<td>2000mm</td>
</tr>
<tr>
<td>601mm to 1200mm</td>
<td>40mmx40mmx16gauge</td>
<td>10mm</td>
<td>2000mm</td>
</tr>
<tr>
<td>1201mm to 1800mm</td>
<td>50mmx50mmx5mm MS angle iron duly painted</td>
<td>12mm</td>
<td>2000mm</td>
</tr>
<tr>
<td>1801mm &amp; above</td>
<td>65mmx65mmx6mm MS angle iron duly painted</td>
<td>12mm</td>
<td>2000mm</td>
</tr>
</tbody>
</table>

e. Ducting over false ceiling shall be supported from the slab above, or from beams, after obtaining approval of Client’s site representative/Architects. 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 ducts shall be taken from structural slab/wall by means of fastener.

f. Where ducts pass through brick or masonry openings, it shall be provided with 25 mm thick TF quality expanded polystyrene around the duct and totally covered with mortar for complete sealing. Contractor shall ensure that contact between metal duct and mortar is avoided.

g. 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 vibration in the ducts, ducts shall be provided with a fire resistant double flexible connection, located at the unit discharge. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve at least 100mm 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 sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation.

h. In case of grid type false ceiling, the entire diffuser assembly with plenum shall be independently hung from the ceiling through adjustable GI wires and the same shall be connected to the main duct through a flexible round duct.

i. Duct shall not rest on false ceiling and shall be in level from bottom. Taper pieces shall taper from top.

j. Suitable arrangement shall be provided in duct for fixing of duct smoke sensor (supplied by other vendor).

k. Toilet exhaust duct shall be provided with goose necking as shown in design drawings and exhaust shall continue operation in case of fire.

**Duct Support with Steel Wire Rope Hangers**

Wire Hangers with following specifications shall be used to suspend static HVAC Air Distribution services as required.

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 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, UL, CSA, Chiltern International fire, ADCAS, Intertek, ECA, and SMACNA, approved by ULC and 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.

\[
\text{Weight per meter of object suspended (kg) } \times \text{Distance between suspension points (m)} = \text{weight loading per Hanger suspension point (kg)}.
\]

Where the installed wire rope is not vertical then the working load limit shall be reduced in accordance with the manufacturer’s recommendations.
The contractor shall select the correct length of wire rope required to support the service. Lengths from 1-10m lengths. Specials can be made, check with manufacturer. No in–line joints should be made in the rope.

<table>
<thead>
<tr>
<th>Wire (Gripple) Hanger Safe Working Loads</th>
</tr>
</thead>
<tbody>
<tr>
<td>size</td>
</tr>
<tr>
<td>No. 1</td>
</tr>
<tr>
<td>No. 2</td>
</tr>
<tr>
<td>No. 3</td>
</tr>
<tr>
<td>No. 4</td>
</tr>
<tr>
<td>No. 5</td>
</tr>
<tr>
<td>No. 6</td>
</tr>
</tbody>
</table>

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. It should be noted that the testing has been done to the minimum breaking load of the wire giving a minimum safety factor of 5: 1.

Ducting Supports:

a. 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 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 using Gripple 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 non availability of RCC slab Hanger wires shall then hang around the structural support without use of fastners.

b. 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 under ducts at no greater than 1800mm centre, for 1801mm-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 connection. Support ducting in accordance with Schedule I at the end of this Section.
Any other Gripple solution can be used based on manufacturer’s recommendation on site
conditions after prior approval. 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.

c. 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.

Catenary Supports: Refer to manufacturer’s recommendations on Catenary supports with C clip,
special care should be taken with tensioning of the wire and angles at which the installation of
services are made.

Stainless Steel Supports should be used for food, chemical and High Corroding environments
like areas near coastlines.

Installation should comply with manufacturer's load ratings and recommended installation
procedures.

Schedule I: Duct Hanger Schedule

For ducts with external SP upto 250 Pa

<table>
<thead>
<tr>
<th>Maximum Duct Size (mm)</th>
<th>Gauge</th>
<th>Gripple Hanger No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 750</td>
<td>26</td>
<td>2</td>
</tr>
<tr>
<td>751-1000</td>
<td>26</td>
<td>2</td>
</tr>
<tr>
<td>1001-1200</td>
<td>24</td>
<td>3</td>
</tr>
<tr>
<td>1201 - 1500</td>
<td>24</td>
<td>3</td>
</tr>
<tr>
<td>1501 - 1800</td>
<td>22</td>
<td>4</td>
</tr>
<tr>
<td>1801-2100</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td>2101-2700</td>
<td>18</td>
<td>4</td>
</tr>
</tbody>
</table>

For ducts with external SP upto 500 Pa

<table>
<thead>
<tr>
<th>Maximum Duct Size (mm)</th>
<th>Gauge</th>
<th>Gripple Hanger No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–600 mm</td>
<td>26</td>
<td>2</td>
</tr>
<tr>
<td>601-750 mm</td>
<td>26</td>
<td>2</td>
</tr>
<tr>
<td>751-1000 mm</td>
<td>24</td>
<td>3</td>
</tr>
<tr>
<td>1001-1200 mm</td>
<td>22</td>
<td>4</td>
</tr>
<tr>
<td>1201-1300 mm</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td>1301-1500 mm</td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td>1501-1800 mm</td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td>1801-2100 mm</td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td>2101-2250 mm</td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td>2251-2400 mm</td>
<td>18</td>
<td>4</td>
</tr>
</tbody>
</table>
Note: All supports are considered at not more 2000 mm interval.

4. **Flat Oval Ductwork**

4.1 Flat oval duct shall be provided where shown and as shown on the tender drawings.

4.2 Minimum duct wall thickness shall be as indicated in below:

**Flat oval duct gauge positive pressure to 10 in.wg.**

<table>
<thead>
<tr>
<th>Major Dimension Duct Width (inch)</th>
<th>Longitudinal Seam</th>
<th>Spiral Seam</th>
<th>Fitting Gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>TO 24</td>
<td>20</td>
<td>24</td>
<td>20</td>
</tr>
<tr>
<td>30</td>
<td>20</td>
<td>22</td>
<td>20</td>
</tr>
<tr>
<td>36</td>
<td>20</td>
<td>22</td>
<td>20</td>
</tr>
<tr>
<td>42</td>
<td>18</td>
<td>22</td>
<td>18</td>
</tr>
<tr>
<td>48</td>
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</tr>
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<td>54</td>
<td>18</td>
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</tr>
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<td>60</td>
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<td>20</td>
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</tr>
<tr>
<td>60</td>
<td>16</td>
<td>20</td>
<td>16</td>
</tr>
<tr>
<td>71 and UP</td>
<td>16</td>
<td>18</td>
<td>16</td>
</tr>
</tbody>
</table>

**Flat oval duct gauge positive pressure to 2500 Pa.**

<table>
<thead>
<tr>
<th>Major Dimension Duct Width (mm)</th>
<th>Longitudinal Seam (mm)</th>
<th>Spiral Seam (mm)</th>
<th>Fitting Gauge (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TO 600</td>
<td>1.00</td>
<td>0.70</td>
<td>1.00</td>
</tr>
<tr>
<td>750</td>
<td>1.00</td>
<td>0.85</td>
<td>1.00</td>
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<tr>
<td>900</td>
<td>1.00</td>
<td>0.85</td>
<td>1.00</td>
</tr>
<tr>
<td>1000</td>
<td>1.31</td>
<td>0.85</td>
<td>1.31</td>
</tr>
<tr>
<td>1200</td>
<td>1.31</td>
<td>0.85</td>
<td>1.31</td>
</tr>
<tr>
<td>1300</td>
<td>1.31</td>
<td>1.00</td>
<td>1.31</td>
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<tr>
<td>1500</td>
<td>1.31</td>
<td>1.00</td>
<td>1.31</td>
</tr>
<tr>
<td>1650</td>
<td>1.61</td>
<td>1.00</td>
<td>1.61</td>
</tr>
<tr>
<td>1775 and UP</td>
<td>1.61</td>
<td>1.31</td>
<td>1.61</td>
</tr>
</tbody>
</table>

4.3 Reinforcement for flat sides of oval duct shall be of the same size and spacing interval as specified for rectangular duct or shall be provided to limit wall deflection to 3/4 (19mm) and reinforcement deflection to 1/4 (6.4 mm).

4.4 Unless otherwise specified, joints and seams shall be similar to those indicated for round duct.

4.5 Fittings shall conform to the thickness schedules in Table 3-15, shall conform to the seam, joint, and connection arrangements permitted for round duct, and shall be reinforced to conform to 2.4.3.

4.6 The duct construction shall be capable of withstanding a pressure 50 percent greater than that of the assigned pressure class without structural failure or permanent deformation.
4.7 Duct wall deflection at atmospheric pressure, with reinforcements and connections in place, shall not exceed 1/4 in. (6.4 mm) on widths of 36 in. (914 mm) or less or 1/2 in (13 mm) on greater widths. Refer Criteria in Chapter 11 of SMACNA Standards 2005 Third Edition.

4.8 Supports shall conform to those permitted for rectangular duct, with the overall dimensions taken as references.

4.9 Documentation & Measurement of ducting

All ducts fabricated and installed should be accompanied and supported by following documentation:

a. For each drawing, all supply of ductwork must be accompanied by computer generated detailed bill of materials indicating all relevant duct sizes, dimensions and quantities. In addition, summary sheets are also to be provided showing duct area by gauge and duct size range as applicable.

b. Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge-wise.

c. All duct pieces to have a part number, which should correspond to the serial number, assigned to it in the measurement sheet. The above system will ensure speedy and proper site measurement, verification and approvals.

4.10 Testing

After duct installation, total duct work (Air conditioning and Mechanical Ventilation Ducts for Kitchen and toilet exhaust) carried out under this scope of works should be tested for leakage. The procedure for leak testing should be followed as per SMACNA - HVAC Air Duct Leakage test manual” (First Edition-1985)

4. Air Terminals

4.1 Dampers

4.1.1 Opposed blade type louver dampers with quadrant and thumb screw lock shall be used at supply air collars for balancing of air distribution system and box type volume control dampers having lever operation shall be used at the outlet of air conditioning equipment or as shown on the approved shop drawings.

4.1.2 All dampers shall be multi blade type of robust construction of galvanized steel unless and until specified otherwise in the Bill of Quantities and tightly fitted. The design, method of handling, and control shall be suitable for the location and service required.

4.1.3 Dampers shall be provided with suitable links, levers and quadrants as required for their proper operation; control or setting devices shall be made robust, easily operable and accessible through suitable access doors in the ducts. Every damper shall have an indicating device clearly showing the damper position at all times.
4.1.4 Dampers shall be placed in ducts and at each supply air collar, whether or not indicated on the drawings, for the proper volume control and balancing of the system.

4.1.5 Automatic and manual volume control opposed blade dampers shall be complete with frames and bronze bearings as per drawings. Dampers and frames shall be constructed out of 1.6mm steel sheets and blades shall not be over 225mm wide. The dampers for fresh air inlet shall additionally be provided with fly mesh screen, on the outside, of 0.8mm thickness with fine mesh.

4.1.6 Wherever required for system balancing, a volume balancing opposed blade damper with quadrant and thumb screw lock shall be provided.

4.1.7 After completion of the duct work, dampers are to be adjusted and set to deliver air flow as specified on the drawings.

4.2 Double Louvered Grilles

4.2.1 The supply air grilles shall be fabricated from extruded aluminium sections. The supply air grilles shall have double adjustable louvers i.e. front horizontal and rear vertical louvers, both adjustable. The louvers shall be suitable to hold deflection settings under all conditions of velocity and pressure. The grilles shall be provided with outer frame. The louvers shall be pivoted in Nylon bushes for smooth operation for return air grilles similar to supply air as described above will be provided but with out volume control damper. The grilles shall be painted as per approved powder coated shade.

4.2.2 Volume control dampers in extruded aluminium construction shall be factory fitted for supply air grilles.

4.2.3 Longer grilles having size more than 45cm shall have intermediate supports for the horizontal louvers. The sample of grille shall have to be got approved by the consultants before delivery.

4.3 Linear Grilles

4.3.1 The linear supply cum return air grilles shall be fabricated from extruded aluminium sections. Flanges shall be of minimum 1.3 mm thick extruded aluminium suitable to hold the louvers tightly in fixed position.

4.3.2 Louvers shall be minimum 3mm thick throughout of extruded aluminium construction with 15 degree deflection unless and until specified otherwise. Grilles shall be provided with removable/fixed internal core as mentioned in the BOQ. The sample of grille shall have to be got approved by the consultants before delivery.

4.3.3 All sections of grills shall be powder coated for color and shade as approved by the Architects to match interior finishes.

4.3.4 Linear grilles at each supply air outlet shall be provided with volume control dampers as mentioned above and accounted for in BOQ separately. The linear grilles shall be fixed in to a plenum chamber having GI spacers with concealed screws. End pieces or corner pieces shall be provided as required.
4.4 Diffusers

4.4.1 Square ceiling diffuser shall be anti-smudge ring type fabricated out of extruded aluminium sections. The four directional air flow diffuser shall consist of outer ring fixed to duct collar with concealed screws. Foam gasket shall be provided between outer ring and suspended ceiling. The central core shall be clip fixed to the outer ring.

4.4.2 Opposed blade volume control damper in extruded aluminium construction shall be fixed to the neck of diffuser. The damper shall be adjusted after removing the central core.

4.4.3 All sections of diffusers shall be powder coated for color and shade as approved by the Architects to match interior finishes. The sample of diffuser shall have to be got approved by the consultants before delivery.

4.5 Multislot Linear Diffuser

Linear ceiling diffuser shall be multislot type. The diffuser shall be fabricated out of extruded aluminium sections. Each slot shall be 19mm wide. Each slot shall be equipped with air flow direction control louver mechanically fixed. Integral sliding type hit & miss type volume control damper in extruded aluminium construction shall be provided for each slot for fine control of air flow in supply air portion only. The damper shall be fabricated out of anodized extruded aluminium sections.

Other sections of ceiling diffuser shall be powder coated in colour & shade approved by the Consultants/Architects.

The linear diffuser shall be fixed in to a plenum chamber with concealed screws. Side end pieces or corner pieces shall be provided if required.

4.6 Air Transfer Grille

4.6.1 Air transfer grilles shall be in extruded aluminium construction. The grilles shall be complete with single /double frame suitable to be fixed on the door panel from both sides. The central core shall be no-see-thru type.

4.6.2 The grilles shall be anodized or powder coated in colour and shade as approved by the Architects. The grilles shall be provided with insect screen.

4.6.3 The ATGs shall be provided at the door of pantry and toilets as shown in the approved drawings. The sample of grille shall have to be got approved by the consultants before delivery.

5. Painting

5.1 All grilles and diffusers shall be powder coated at factory prior to delivery at site of approved color and shade.

5.2 All ducts immediately behind the grilles/diffusers etc. to be applied with two coats of black paint in matt finish.
6. Fire cum Smoke Dampers

Bare Dampers

a. All supply and return air ducts/ return air spaces at AHU room crossings and at all floor crossings shall be provided with approved make motorized fire and smoke dampers of at least 90 minutes fire rating as certified by CBRI Roorkee, India as per clause 10 of UL:555-1995. These dampers shall be multi-leaf type –Ruskin.

b. Fire damper blades and outer frame shall be formed out of 1.6mm (16G) galvanized steel sheet of length as mentioned in the approved for construction shops drawings tilted as AHU Room Blow Up. The damper blade shall be pivoted on both ends using chrome-plated spindles in self-lubricated bronze bushes. Stop seals shall be provided on top and bottom of the damper housing made of 16 gauge galvanized sheet steel. For preventing smoke leakage, metallic compression side seals shall be provided. Dual side leakage shall be provided for better structural stability. The construction of the fire damper shall allow maximum free area to reduce pressure drop and noise in the air passage, in normal position damper blade shall be held in open position with the help of a 220 V operated electric actuators thereby providing maximum air pressure without creating any noise or chatter.

c. For wall mounted fire dampers retaining MS angles duly painted with black enamel paint shall be supplied and installed by HVAC Contactor as per established installation procedure. Whereas the fire damper is also used for Smoke management (Smoke and fire damper) the same shall be as per UL-555 S-Class-II.

d. Every motorized fire damper/ Smoke and fire damper shall be tested in the factory and will be certified by the manufacturer in form of the test certificate.

e. Fire dampers shall also be supplied with spring locked fusible link rated for 72°C (UL stamped) to close fire damper in event of rise in duct temperature.

f. For fire dampers/ smoke fire dampers of size higher than one approved by certifying agency the damper shall be supplied in multiple units of size not exceeding the tested damper by CBRI. All the multiple units shall be housed in a common factory fitted sleeve.

g. The fire dampers shall be mounted in fire rated wall with a duct sleeve 400mm/ 500mm long depending upon the wall thickness. The sleeve shall be factory fitted on fire damper. The joints at sleeve end shall be slip on type. Minimum thickness of galvanized sheet shall be 18 gauge.

h. The damper shall be installed in accordance with the installation method recommended by the manufacturer.

Actuators

The actuator shall be maintenance free coupled spring return type suitable to work on 24V electric supply. The torque rating of the actuator shall exceed at least by 15% over torque required to open/ close the damper. The selection of actuator size shall be the responsibility of the manufacturer of the fire damper. Spring return time shall be 20 seconds or less at ambient temperature. Other features of the damper actuator shall be as under:
a. Actuator shall have tamper proof housing with IP-54 protection rating.

b. Actuator shall have mechanical integrity of at least one hour at 900°C.

c. Actuator shall have minimum 600000 safe position at rated torque. It shall be capable to withstand temperature of 75°C for 24 Hrs.

d. Actuator shall have electronic over load or digital sensing circuit to prevent damage to actuator.

e. Should be capable of changing direction of rotation by changing mounting orientation.

f. Actuator shall have manual over ride facility.

Damper actuator shall be such that it should close the damper in the event of power failure automatically and open in the same manner in case of power being restored.

**Control Panels**

The control panel shall be supplied by damper manufacturer fitted on damper compatible with damper actuators. The control panel shall have at least following features:

a. Power on lamps with 230 V/ 24 V Transformer.

b. Damper close and open indication.

c. Reset push button.

d. Push button for manual running of actuator for periodic inspection.

e. Auxiliary contacts 24V/ 230V.

f. Contact points to receive signal from smoke detector/ fire alarm panel.

g. Additional terminal shall be provided to have signal (audio or visual) in central control room.

In addition the Control panel shall have following features as well :  

- Potential free contacts for AHU fan/Pkg Unit ON/ Off and remote alarm indication.
- Accept signal from external smoke / fire detection system for tripping the electrical actuator.
- Test and reset facility.
- Indicating lights / contacts to indicate the following status:
  - Power Supply On
  - Alarm

The control panel shall receive 230V A/C supply and interconnecting wiring between control panel and actuator shall be carried out using fire proof cables.

The Contactor shall ensure that all electrical connections are suitably terminated. The HVAC Contractor shall also check continuity of electrical circuit as recommended by the manufacture. Fire damper inspection door will be provided in AC duct to facilitate access to the system.

7. **Flexible Ducts**
The scope of this section comprise supply, installation testing and commissioning of flexible ducting conforming to these specifications and in accordance with requirements of drawings and schedule of quantities.

Wherever specified, uninsulated flexible duct shall be made of double lamination of metalized aluminium film permanently bonded to a coated spring steel wire helix. Duct shall be in tear and puncture resistant construction.

Wherever insulated flexible ducts are specified, inner core for the same should be made of double lamination of aluminium permanently bonded to a coated spring steel wire helix. Fiberglass insulation of minimum 24Kg/m$^3$ density, 25mm thickness shall be wrapped over the inner core and covered with strong outer jacket cum vapour barrier made of fibreglass reinforced metalized polyester film laminate.

Care must be taken to install all flexible ducts in fully extended position and bends made with adequate radius as per manufacturer recommended practices.

8. **Testing and Balancing**

8.1 After completion of the installation of the complete air distribution system, all ducts shall be tested for air leaks.

8.2 Before painting the interiors, air distribution system shall be allowed to run continuously for 48 hours for driving away any dust or foreign material lodged within ducts during installation.

8.3 The entire air distribution system shall be balanced using approved anemometer. Air quantities at the fan discharge and at various outlets shall be identical to, or less than 5 percent in excess of, those specified and quoted. Leakage in each air distribution system shall be within 3 percent so that supply air volume at each fan shall be identical to, or no greater than 3 percent in excess of, the total air quantity measured at all supply outlets served by the fan. Branch duct adjustments shall be made by volume or splitter dampers. Dampers shall be permanently marked after air balance is complete so that these can be restored to their correct position if disturbed at any time. Complete air balance report shall be submitted to the Consulting Engineer for scrutiny and approval, and six copies of the approved report shall be provided with completion documents.

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E. **“SPECIFICATIONS - INSULATION”**

1. **Scope**

The scope of this section comprises of supply and application of insulation conforming to these Specifications and as shown on the drawings & BOQ.

2. **Duct Insulation (External)**

**Material**

Insulation material shall be closed cell elastomeric material (nitrile rubber) having fire retardant Class “O” properties. Density of insulation material shall range between 0.04-0.07 gm/Cucm. Thermal conductivity (K value) at 40 C mean temperature and Service temperature limit shall be 0.039 W/M.K and –40C to 105C respectively. Water vapour permeability shall not be less than 7000 Kg/Pa/s.m. Water absorption shall not be more than 1.5% by weight. Insulation material shall have excellent ozone resistance properties. Excellent Thermal Stability. Insulation material shall be tested for the said properties in accordance with the relevant international codes including BS 874 Part 2 1986, DIN 52612(K Value), DIN 52615 (Water vapour permeability), BS 476 Part6 & Part7 (Flammability).

**Application**

Duct insulation shall be applied as follows :

a. External surface of the ducts to be cleaned vigorously to remove dirt and any other foreign material from the surface of the ducts.

b. Apply Low VOC adhesive AC duct King Eco Fresh/equivalent on the surface of ducts.

c. Wrap factory aluminum foil laminated/IC cladding finish closed cell insulation material having thickness as mentioned in BOQ butting all joints. All joints to be sealed with adhesive.

3. **Acoustic Lining**

3.1 **Material**

Insulation material shall be resin bonded fibre glass. The Thermal conductivity of the insulation material shall not exceed 0.034 K cal./ hr-SqM C/M or 0.27 Btu/hr sft- F/inch at 32 C (90 F) mean temperature, and density shall not be less than 32 Kg/ CuM (2.0 lb/c.ft). Thickness of the insulation shall be as specified for the individual application. Samples of insulation material shall be submitted for approval.

3.2 **Application**
3.2.1 **Duct Lining (Internal)**

Acoustical lining of duct wherever specified shall be applied as under:

a. Internal surface of the ducts to be cleaned vigorously to remove dirt and any other foreign material from the surface of the ducts.

b. 22 gauge G.S. Sheet channel frames having size 25mm wide & depth equal to thickness of insulation to be fixed at maximum 600mm centre, screwed to the sheet metal using brass metal screws.

c. Fibre Glass blankets of 32 Kg/CuM density and thickness as mentioned in the BOQ to be fixed in the G.S. sheet channel frame work with joints well butted together. Thereafter, insulation shall be covered with R.P tissue.

d. Finally cover the insulation with 26 SWG perforated aluminium sheet having at least 20% perforation with joints overlapped and screwed to the G.S. Sheet channel frame using brass metal screws, to produce an even surface.

OR

3. **Acoustic Lining of Ducts**

3.1 **Material**

Acoustic insulation material shall generally possess the properties mentioned above, however, insulation material shall be processed Nitrile Rubber Foam having fire retardant Class “O” properties. Density of insulation material shall range between 140-180 Kg/CuM. The insulation material shall conform to the international codes including BS 476 Part 6 & Part 7 (Flammability).

3.2 **Application**

Acoustical lining of duct wherever specified shall be applied as under:

a. Internal surface of the ducts to be cleaned vigorously to remove dirt and any other foreign material from the surface of the ducts.

b. Apply Low VOC adhesive AC duct King Eco Fresh/equivalent on the surface of ducts.

c. Cut foamed sheets into required sizes using sharp knives. Apply adhesive on the foam and stick it to the duct surface.

**Note: Specifications shall be applicable as specified in the BOQ**

4. **Exposed Ducts Thermal Insulation**

**Material**
Insulation material shall be closed cell elastomeric material (nitrile rubber) having fire retardant Class “O”. Density of insulation material shall range between 0.04-0.07 gm/Cu cm. Thermal conductivity (K value) at 40 C mean temperature and Service temperature limit shall be 0.039 W/M.K and –40C to 105C respectively. Water vapour permeability shall not be less than 7000 Kg/Pa/s.m. Water absorption shall not be more than 1.5% by weight. Insulation material shall have excellent ozone resistance properties. Excellent Thermal Stability. Insulation material shall be tested for the said properties in accordance with the relevant international codes including BS 874 Part 2 1986, DIN 52612(K Value), DIN 52615 (Water vapour permeability), BS 476 Part6 & Part7 (Flammability).

**Application**

Duct insulation shall be applied as follows:

a. External surface of the ducts to be cleaned vigorously to remove dirt and any other foreign material from the surface of the ducts.

b. Apply Low VOC adhesive AC duct King Eco Fresh/equivalent on the surface of ducts.

c. Wrap closed cell insulation material having thickness as mentioned in BOQ butting all joints. All joints to be sealed with adhesive.

d. Cover the insulation with necessary glass cloth & ultraviolet (UV) paint towards protection from atmospheric abuse.

OR

4. **Exposed Ducts Thermal Insulation**

4.1 **General**

The insulation of ducts exposed to atmosphere shall be carried conforming to these Specifications and as shown on the drawings.

4.2 **Material**

Exposed ducts shall be insulated with rigid preformed sections of TF quality expanded polystyrene of density not less than 24Kg/CuM and thickness as indicated in the Schedule of Quantities.

4.3 **Application**

Method for application of Insulation externally shall be as given hereunder:

a. Duct surface shall be cleaned thoroughly and thereafter applied with hot bitumen 85/25 over the cleaned surface.

b. TF quality rigid expanded polystyrene insulation material in specified thickness to be fixed tightly to the surface with joints well butted and secured. All joints to be sealed properly with CPRX compound.
c. Cover the insulation with a two layers of 500G polythene sheet to work as vapour barrier.

d. Finally apply necessary glass cloth coating & UV protection paint of approved make to protect the insulation material from atmospheric abuse.

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F. 

“SPECIFICATIONS - ELECTRICAL WORK”

1. **Scope**

In general, the contractor shall supply, store, erect, test and commission all the equipment required for Electrical Installation. The contractor shall furnish all the materials, labour, tools and equipments for the electrical work, as shown in the accompanying drawings and in the bill of quantities and specifications hereinafter described.

2. **Definitions**

The following abbreviations used in the bill of quantities specifications and drawings represents:

- **ISS** - Indian Standard specification.
- **IER** - Indian Electricity Rules, 1956.
- **BS** - British Standard (where specifically called for)
- **BSCP** - British Standard Code of Practice (if called for).
- **HRC** - High Rupturing Capacity
- **GI** - Galvanised Iron
- **MS** - Mild Steel
- **CI** - Cast Iron
- **APLSTS** - Aluminium conductor, paper insulated lead sheathed, Double steel tape armoured and serving.
- **PVC** - Polyvinyl Chloride.
- **XLPE** - Cross Linked Polyethylene.
- **HT** - High Tension.
- **LT** - Low Tension.
- **A-Amp** - Ampere.
- **KV** - Kilo Volts.
- **PT** - Potential Transformers.
- **CT** - Current Transformers.
- **OCB** - Oil circuit Breakers
- **VCB** - Vacuum Circuit Breaker
- **ACB** - Air Circuit Breakers
- **SFU** - Switch fuse Unit
- **COS** - Change Over Switch
- **CFS** - Combination Fuse Switch
- **MCCB** - Moulded Case Circuit Breaker.
- **MCB** - Miniature Circuit Breaker
- **IC** - Iron Clad
- **ICTPN** - Iron Clad Triple Pole and Neutral
- **ICDP** - Iron Clad Double Pole
- **DB** - Distribution Board
- **KVA** - Kilo Volts Ampere.
- **KVAR** - Kilo Volts Ampere - Reactive.
- **NC** - Normally Close
- **NO** - Normally open
- **SWG** - Standard Wire Gauge.

3. **REGULATION & STANDARDS**
The installation shall conform in all respects to Indian standard Code of Practice for Electrical Wiring Installation I.S. - 732 and ‘National Electrical Code’. It shall be in conformity with the current I.E Rules and Regulations and requirements of the local Electric Supply Authority in-so-far as these become applicable to the installation. Wherever this specification calls for a higher standard of materials and/or workmanship then those required by any of the above regulations, this specifications shall take precedence over the said regulations and standards.

In general, the materials, equipments and workmanship not covered by the above, shall conform to the following Indian Standards (Latest Edition) unless otherwise called for:

a. **SWITCHGEAR**
   - Requirements of A.C. Circuit Breakers. : IS 2516 (Part I) Sec.1,2 & 3 (Part-II)
   - Switches and Switch Isolators above 1000V But Not Exceeding 1.1 KV : IS 4710
   - Markings & arrangements for switchgear bus-bars, main connection & auxiliary wiring : IS 375
   - Specification for normal duty air break switches & composites unit for air break switches and fuses for voltage not exceeding 1000 Volts. : IS 4064
   - Heavy duty air-break switches and composite units of air-break switches and fuses for voltages not exceeding 1000 Volts. : IS 4047
   - Specification for miniature circuit breakers. : IS 8828
   - Specification for enclosed distribution, fuse boards and cut-outs for voltage not exceeding 1000 Volts : IS 2675
   - Installation and maintenance of switchgear. : IS 3072 (Part I)
   - HRC cartridge fuse links 650 Volts. : IS 2208

b. **CABLE & MISCELLANEOUS ITEMS**
   - Specification for paper insulated and lead sheathed cables : IS 692
   - Code of Practice for installation and maintenance of paper insulated power cables (upto and including 33 KV) : IS 1255
   - Specification for PVC insulated (Heavy Duty)
electric cables Part-I for Voltage upto 1100 Volts. : IS 1554

- Specification for PVC insulated cables (for voltage upto 1100 V) (Part-II) with Aluminium conductors. : IS 694 (Part-II)

- Specification for rigid steel conduit for electrical wiring. : IS 9537

- Specifications for rigid non metallic conduits for electrical installations. : IS 9537

- Specifications for accessories for rigid steel conduits for Electrical wiring. : IS 3837

- Box for the enclosure of electrical accessories steel and C.I. Boxes. : IS 5133 (Part I)

- 3Pin plugs and sockets outlets : IS 1293

- Adhesive insulating tapes for Electrical purposes (Part- I & II) : IS 2448

- Propeller type AG Ventilating fans : IS 2312

- Code of Practices for earthing. : IS 3043

- Glossary of terms for electrical cable and conductors. : IS 1885

- Code of Practice for buildings (General) Electrical installation : IS 1646

- Current Transformers : IS 2705 (Part-I to III)

- Voltage Transformer : IS 3156 (Part-I to III)

- Shunt capacitors for Power system : IS 2834

- Direct acting electrical indicating instruments : IS 1246

- Factory assembled switchgear : IS 8623

- Rating for Cable : IS 3961 (Part -II)

- Earthing : IS 3843

3. **INSPECTION & APPROVAL OF THE WORK BY LOCAL AUTHORITY**

On completion of this work, the contractor shall obtain and deliver to the owners the certificates of inspection and approval by electrical inspectorate of Local Administration. The fees paid for
inspection will be reimbursed on production of challan/receipt. The contractor shall include in
his rates all charges necessary for getting electrical installation approved which includes Sub-
station, LT distribution, etc. by the Chief Electrical Inspector to the state government or/ and
from any other authority required for this job.

5. INSPECTION OF MATERIALS

The Architect/ owners shall have access to the manufacturer’s premises for inspection of any
items of the tender for which contractor has made arrangement with manufacturer/ suppliers.
All such inspection shall not need any prior intimation by the owners or architects.

6. WORKING DRAWINGS & SHOP DRAWINGS

The contractor shall prepare and submit to the Architects/ owners for approval detailed working
drawings & shop drawings of all MCC/panels, cable layout, earthing etc.

7. AS BUILT DRAWINGS

At the completion of the work and before issuance of certificate of virtual completion, the
contractor shall submit to the Architect/ employers layout drawings drawn on tracing film and
approved scale indicating the complete wiring as installed.

8. ENGINEER/ SUPERVISOR

The contractor shall employ a competent, licence, qualified full time electrical engineer /
supervisor to direct the work of electrical installations in accordance with the drawings and
specifications. The engineer / supervisor shall be available at all times at the site to receive
instructions from the Architect/employers in any day to day activities throughout the duration of
the contract. The engineer & supervisor shall correlate the progress of the work in conjunction
with all the relevant requirements of the supply authority. The skilled workers employed for the
work should have requisite qualifications and should possess competency certificate from the
Electrical Inspectorate of Local Administration.

9. APPLICATION FOR ELECTRIC SUPPLY/ LIASON

The Contractor shall be responsible for filing and follow up application for electric supply to the
project. The contractor shall carry out all the liason work required for obtaining electric supply
at site commencing from filing of application. This liason shall be deemed to be a part of the
contract.

GENERAL SPECIFICATION FOR: MEDIUM VOLTAGE POWER CONTROL
CENTRE AND SWITCH BOARD PANELS:

1.1 GENERAL:
Medium voltage power control centres (generally termed as switch board panels) shall be in sheet steel clad cubicle pattern, free floor standing type, totally enclosed, compartmentalized design. This specification shall cover the following types of panels:

a) Air circuit breaker panels - Drawout type with single or double tier arrangement as per design shown on the drawings.

b) Panels with one or more Air circuit breakers with Draw-out arrangement and switch-fuse units/moulded case circuit breaker of non-drawout design.

c) Panels with switch-fuse unit/moulded case circuit breaker of non-drawout type. However, the switch-fuse units can have drawout fuse-carriage if a particular make of switch-fuse is used.

The panels shall generally be of extensible type with provision for bus extension on or both sides as desired at the time of approved of shop drawings.

1.2 CODE/STANDARDS:

The panels shall generally conform to the requirements of following codes/specifications:

- IS-8623
- IS-4237
- IS-2147
- IS-3072
- IS-375
- IS-1248 & 2419
- IS-5082
- IS-2705
- IS-722
- IS-4064
- IS-2208
- IS-6875
- IS-6005

The equipment shall conform to Indian Electricity Rules as amended upto-date.

The supplier shall examine the provision of these codes and confirm or indicate his comments.

1.3 CONSTRUCTION:

Power control centres/ switch board panels shall of free standing type, with sheet steel enclosure having following features:

a) The panel shall be constructed of sheet steel of minimum 1.6mm thickness. The internal frames shall be made of structural steel angles or made up sections (as per standard design of the manufacturer) specifications of which, shall be submitted along with offers.

b) The panel shall be compartmentalised to accommodate one feeder in each compartment. The main bus bar chamber shall be provided at the top of panel or bottom of the panel as required. The compartments shall be arranged in section with metallic/phenolic barrier in between.

A vertical cable alley of at least 200mm width shall be provided to serve one/two vertical section of feeders. Cable alley shall have hinged door/doors with rubber gaskets. Suitable cable clamping arrangement with slotted steel members shall be provided in the cable alley. Similarly, vertical bus bar shall be housed in-between two feeder compartments in a
separate bus chambers. The opening between bus chamber and feeder compartments shall be properly covered with Bakelite/ Hylam sheets of 3mm minimum thickness. The vertical bus chamber shall be provided with removable bolted covers on the front and back side. All the interconnecting links to the feeders shall be shrouded so as to avoid accidental contact, by means of phenolic barriers.

c) Each compartment shall have its own hinged door with concealed hinges. The doors shall have heavy duty rubber gasket fixed on the inner side of the door. The door shall have interlocking facility with the feeder unit.

d) The Panel shall have punched openings for mounting meters, lamps, push buttons, relays, etc.

e) The dimensions of feeder compartments, bus chambers and cable alleys shall be as shown on the relevant drawings. However, the following minimum dimensions shall be strictly adhered to:

i. ACB compartment : Drawout - 600mm wide x 1000mm deep x 900mm high.

ii. SWITCH FUSE UNITS/MOULDED CASE CIRCUIT BREAKER (NON-DRAWOUT TYPE):

Up to 63A/ 100A : 300mm wide x 225mm high x 400mm deep
250A : 400mm wide x 400mm high x 400mm deep
400A to 630A : 400mm wide x 500mm high x 400mm wide.
(or vice-versa).

iii. BUS CHAMBER :
Main bus (Horizontal) : 400mm high x 300mm deep
Vertical bus (Feeder bus) : 300mm wide x 400mm deep

iv. Cable alley : Min. 200mm wide.

These dimensions are furnished as a guide and the clearances required in between each live bus/ link and between bus/ links to the earth (panel wall/ sheet) shall be as per relevant Indian Standard Code of practice. However, minimum clearance between neutral bus and earth shall not be less than 25mm. The panel supplier shall furnish detailed sectional drawings and also arrange to get the panel inspection done at intermediate stages of fabrication to avoid fault defective fabrication of the panels (however, the compliance of these specifications shall entirely be the suppliers’ responsibility).

1.4 BUS BARS :

a) The bus bars shall be suitable for 3 phase, 4 wire, 415 volts 50 Hz AC supply. The bus bars shall be made of high conductivity aluminium. The bus bars shall have uniform cross-section throughout the length. The bus bars shall be designed for carrying rated-current continuously. The bus bars and links shall be designed for a maximum temperature of 75°C. The max. current density of bus bars shall be as follows:
i. Copper : 1.86 Ampere/ Sq.mm. of cross section area.
ii. Aluminium : 1.28 Ampere/ Sq.mm. of cross section area.

It may be noted that these ratings are the upper limit to which the bus could be stressed. Suitable derating factors shall be applied to arrive at the correct cross section of bus bars.

b. Bus bars shall be supported on suitable non hygroscopic, non combustible, material such as DMC/ SMC at sufficiently close intervals to prevent bus bar sag. All bus bar joints shall be provided with high tensile steel bolts (electro plated with suitable metal such as Nickel/ Cadmium), spring washer and nuts so as to ensure good contact. Alternatively, electroplated/ tinned brass bolts shall be used. The joints shall be formed with fish-plates on either side of bus bar to provide adequate contact area. Bus supports shall be provided on either side of joints (max. unsupported distance from the joint 400mm)

c. Power shall be distributed to feeders in dual section by a set of vertical bus bars (Phases+neutral). Individual module shall be connected to the vertical bus bars through sleeved connections.

d. Bus bars shall be insulated with PVC sleeves (heat shrink type) with colour coding (Red/ Blue/ Yellow/ Black).

e. The bus bars and their supports shall be able to withstand thermal and dynamic stresses due to the system short-circuits. The supplier shall furnish calculations alongwith his drawing establishing the adequacy of bus bars both for continuous duty and short -circuit rating. Short circuit withstand capacity shall be for one second. Calculations for spacing of supporting of supports shall also be furnished.

1.5 EARTHING :

The panels shall be provided with a copper earth bus running throughout the width of the switchboard. Suitable earthing eyes/bolts shall be provided on the main earthing bus to connect the same to the earth grid at the site. Sufficient number of star washers shall be provided at the joints to achieve earth continuity between the panels and the sheet metal parts.

1.6 MOUNTINGS :

Panels incorporating switchfuse units shall have suitable compartments of standard width. Each compartment shall incorporate a heavy duty load break switch fuse and HRC fuses. Suitable cable termination arrangement shall be provided for switch fuse/ fuse-switch unit feeders. Equipment shall be provided with proper fastening arrangements to ensure vibration free operation. Proper designation as given on the respective drawings, shall be provided for every equipment.

Circuit breakers shall be mounted such that they are accessible from the front of the panel. More than two circuit breakers shall not be incorporated in a vertical section. The breakers compartment shall be divided into two parts, one for the breaker and the other for incorporating associated control gear. The necessary instrumentation shall be provided on the door of the compartment.
1.7 INTERLOCKING

The panels shall be provided with the following interlocking arrangements:

a. The door of the feeder compartments is so interlocked with the switch drive or handle that the door can be opened only if the switch is in “OFF” position. De-interlocking arrangement shall also be provided for inspection.

b. It shall not be possible for the breakers to be withdrawn when in “ON” position.

c. It shall not be possible for the breakers to be switched “ON” unless it is either in fully inserted position or for testing purposes it in fully isolated position.

d. The breaker shall be capable of being racked into “testing”, “isolated” and maintenance position and kept in any of these positions.

e. A safety catch to ensure that the movement of the breaker as it is withdrawn, is checked before it is completely out of the cubicle shall be provided.

1.8 PROTECTION AND INSTRUMENTATION:

Protection and instrumentation shall be as per standard specification.

1.9 WIRING

All the interconnections between the incoming, bus and the outgoings of 100A and above rating shall be done by insulated links/ strips of suitable sizes. Switch fuses and equipments below 100A rating shall be wired with PVC insulated copper conductors. The wiring for instrumentation protection and control equipment shall be carried out with PVC insulated flexible copper conductors.

The Power interconnections shall be carried out by means of bolted connections with washers. The wiring shall be terminated by using crimping sockets. Wiring shall be laid out neatly in bunches which are fastened to the steel members of the panel. All the potential circuits shall be protected by fuses mounted near the tap-off point from the main connections.

1.10 TERMINALS:

All the control, instrumentation and protection wiring shall be provided with printed PVC ferrules at both ends. For terminating control cables on to the equipment in the panels, suitable terminals blocks shall be provided. The terminal shall also be numbered for easy identification and maintenance.

1.11 SURFACE TREATMENT

All sheet metal accessories and components of power, control centres and switchboard panels shall be thoroughly cleaned, degreased, derusted and phosphatised before redioxide primer is applied. The panel shall be stove enameled to the required final finish. The interior surfaces of the panel shall also be painted to required shade. The supplier shall indicate in his offer, if there is any deviation from the treatment specified above.
1.12 ENCLOSURES

The panel enclosure shall be dust and vermin proof and shall be suitable for indoor installation. Enclosure design shall be in accordance with the requirements of IP 54 as per IS-2147-1962. The supplier shall confirm whether this requirement is met and a type test certificate furnished. If type test certificate for IP-54 is not available, the same shall be brought out clearly in his offer.

1.13 NAME PLATE

The panel as well as the feeders compartment doors shall be provided with name plates giving the switchboard/feeder descriptions as indicated on the drawings.

1.14 TESTING

The power control centres shall be tested at factory after assembling of all components and completion of all interconnections and wiring. Tests shall be conducted in accordance with the requirements relevant IS Codes/specifications.

a. INSULATION TEST

i. Insulation of the main circuit, that is, the insulation resistance of each pole to the earth and that between the poles shall be measured.

ii. Insulation resistance to earth of all secondary wiring should be tested with 1000V megger.

   Insulation test shall be carried out both before and after high voltage test.

b. HIGH VOLTAGE TEST:

   A high voltage test with 2.5KV one minute shall be applied between the poles and earth. Test shall be carried out on each pole in turn with the remaining poles earthed. All units racked in position and the breakers closed. Original test certificate shall be submitted along with panel.

1.15 STORING, ERECTION AND COMMISSIONING

a. STORING

   The panels shall be stored in a well ventilated, dry places. Suitable polythene covers shall be provided for necessary protection against moisture.

b. ERECTION

   Switchboards shall be installed on suitable foundation. Foundation shall be as per the dimensions supplied by the panel manufacturer. The foundation shall be flat and level. Suitable grouting holes shall be provided in the foundation. The switch boards shall be properly aligned and bolted to the foundation by atleast four bolts. Cable shall terminated on the bottom plate or top plate as the case may be, by using brass compression
glands. The individual cables shall then be lead through the panel to the required feeder compartments for necessary terminations. The cables shall be clamped to the supporting arrangement. The switch board earth bus shall be connected to the local earth grid.

c. **PRECOMMISSIONING TESTS**:

Panels shall be commissioned only after the successful completion of the following tests. The tests shall be carried in the presence of engineer-in-charge.

i. All main and auxiliary bus bar connections shall be checked and tightened

ii. All wiring terminations and bus bar joints shall be checked and tightened.

iii. Wiring shall be checked to ensure that it is according to the drawing.

iv. All wiring shall be tested for insulation resistance by a 1000V megger.

v. Phase sequence/rotation shall be estimated.

vi. Suitable injection tests shall be applied to all the measuring insuring instruments to establish the correctness and accuracy of calibration and working order.

iii. All relays and protective devices shall be tested for correctness of settings and operation by introducing a current generator and an ammeter in the circuit.

**GENERAL SPECIFICATION FOR: MOULDED CASE CIRCUIT BREAKERS**

1.1 **GENERAL**:

Moulded case circuit breakers or fuse free breaker shall be incorporated in the switch board wherever specified. MCCBS shall conform to BS : 3871 Part II or JIS-C-8370 in all respects. MCCBS shall be suitable either for single phase 230V or three phase 415volts.

1.2 **CONSTRUCTION**:

The MCCB and case shall be made of high strength heat resistant and flame retardant thermo-setting insulating material. Operating handle shall be quick make/quick break, trip-free type. The operating handle shall have suitable “ON”, “OFF” and “TRIPPED” indicators. Three phase MCCBS shall have a common operating handle for simultaneous operation and tripping of all the three phase. Suitable arc extinguishing device shall be provided for each contact. Tripping unit shall be of thermal-magnetic type provided on each pole and connected by a common trip bar such that tripping of any one pole actuates three poles to open simultaneously. Thermal magnetic/tripping device shall have IDMT characteristics for sustained over loads and short circuits. Contact tips shall be made of suitable are resistant, sintered alloy for long electrical life. Terminals shall be of liberal design with adequate clearances.
1.3 ACCESSORIES:

MCCBS shall be provided with the following accessories, if specified in schedule of quantities:

i. Under voltage release
ii. Shunt release
iii. Alarm Trip alarm
iv. Auxiliary contacts.

1.4 INTERLOCKING:

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

a. Handle interlock to prevent unnecessary manipulation of the breaker.
b. Door interlock to prevent the door being opened when the breaker is in “ON” position.
c. De-interlocking device to open the door even, if the breaker is in “ON” position.

1.5 RUPTURING CAPACITY:

The moulded case circuit breaker shall have a returning capacity of not less than 10KA Rms at 415 volts. Wherever required, higher rupturing capacity breakers to meet the system short circuit fault shall be used. All such ratings shall be as per equipment schedule/B.O.Q.

1.6 TESTING:

a. Original certificate of the MCCBS as per BS:3871 or JS-C-8370 shall be furnished.
b. Pre-commissioning tests on the switch boards panel incorporating the MCCB shall be done as per specifications.

GENERAL SPECIFICATION FOR: MEDIUM VOLTAGE CABLES

1.1 TYPE:

Medium voltage cables shall be aluminium conductor, PVC insulated, PVC sheathed and steel wire armoured or steel tape armoured construction. Aluminium conductors up to 10sq.mm. may be solid, circular in cross section, and sizes above 10sq.mm. shall be stranded. Sector shaped stranded conductors shall be used for sizes above 25sq.mm. The cable shall conform to IS 1554 (Part I).

1.2 RATING

The cable shall be rated for a voltage of 650/1100 Volts.

1.3 CONSTRUCTION

The conductors for power cables shall be made of electrical purity aluminium & that for control cable from annealed high conductivity copper. The conductors shall be insulated with high quality PVC base compound. A command covering (bedding) shall be applied over the laid up cores by extrusion or wrapping of a filling material containing unvulcanized rubber or
thermoplastic material, armouring shall be applied over the inner shath of bedding, over the armouring a tough outer sheath of PVC sheathing shall be extruded. The outer sheath shall bear the manufacturers name and trade mark at every 30 meter interval.

1.4 **CORE IDENTIFICATION:**

Core shall be provided with the following colour scheme of PVC insulation.

i. Core : Red/Black/Yellow/Blue  
ii. Core : Red and Black  
iii. Core : Red, Yellow, and Blue  
iv. 3.5/4 core : Red, Yellow, Blue and black.

1.5 **CURRENT RATINGS:**

The current rating shall be based on the following conditions.

i. Maximum conductor temperature : 70°C  
ii. Ambient air temperature : 40°C/50°C  
iii. Ground temperature : 70°C  
iv. Depth of laying : 75cm

1.6 **SHORT CIRCUIT RATING:**

Short circuit ratings for the cables shall be as specified in IS : 1554 Part -I.

1.7 **SELECTION OF CABLES:**

Cables have been selected considering the conditions of the maximum connected load, ambient temperature, grouping of cables & the allowable voltage drop. However, the contractor shall recheck the sizes before the cables are fixed and connected to the service.

a. **Storing**

All the cables shall be supplied in drums. On receipt of cables at site, the cables shall be inspected and stored in drums with flanges of the cable drums in vertical position.

b. **Laying**

Cables shall be laid as per the specifications given below. The system adopted for this job shall be as per BOQ :

i. **Cable on Tray/ Racks:**

Cables shall be laid on cable trays/ racks wherever specified. Cable racks/trays shall be of ladder, trough or channel design suitable for the purposes. The nominal depth of the trays/ racks shall be 150mm. The width of the trays shall be as per the design shown on drawing. The cable trays shall be made of steel or aluminium. The trays/ racks shall be completed with end plates, tees, elbows, risers, and all necessary hardware. Steel trays/ Rack shall be painted with two coats of enamel paint of approved shade over a coat of red oxide primer. Cable trays shall be erected properly to present a neat and clean appearance. Suitable cleats or saddles made of aluminium
strips with PVC covering shall be used for securing the cables to the cable trays. The cable trays shall comply with following requirements:

1. The trays shall have suitable strength and rigidity to provide adequate supports for all contained cables.
2. It shall not present sharp edged, burrs or projections injurious to the insulation of the wiring/cables.
3. If made of metal, it shall be adequately protected against corrosion or shall be made of corrosion resistant material.
4. It shall have side rails or equivalent structural members.
5. It shall include fittings or other suitable means for changes in direction and elevation of runs.

1.9 INSTALLATION

1. Cable trays shall be installed as a complete system. Trays shall be supported properly from the building structure. The entire cable tray system shall be rigid.
2. Each run of the cable tray shall be completed before the installation of cables.
3. In portion where additional protection is required, non-combustible covers/enclosures shall be used.
4. Cable tray shall be exposed and accessible.

GENERAL SPECIFICATION FOR: EARTHING FOR ELECTRICAL WORK

1.1 General

All non-current carrying metal parts of the electrical installation shall be earthed as per IS: 3043. All metal conduits, trunkings, cable armour, switchgear, distribution boards, meter, light fixtures, fans and all other metal parts forming part of the work shall be bonded together and connected by two separate and distinct conductors to earth electrodes. Earthing shall also be in conformity with the provisions of Rules 32, 61, 62, 67 & 68 of IER 1956. These specifications apply to both copper and GI earthing system. The material to be used shall be as per that give in BOQ.

1.2 Earthing Conductors

1.2.1 All earthing conductors shall be of high conductivity copper or GI and shall be protected against mechanical damage and corrosion. The size of earth conductors shall not be less than half that of the largest current carrying conductor. The connection of earth continuity conductors to earth bus and earth electrodes shall be strong and sound and shall be easily accessible. The earth tapes shall be joined together using double rivets. The earthing conductor shall be laid in cable trenches, cable trays or conduits or on cable by using suitable clamps.
made of non-ferrous metals compatible with the earthing conductor. The following earthing conductors and required to be used for various sections of the installations.

a. 10SWG bare copper wire or GI wire.

b. All single phase switches and DBs above 30A and upto 63A rating shall be earthed with one run of 8SWG bare copper wire or GI wire.

c. All three phase switches/ DBs upto 30A rating shall be earthed with 2 runs of 10SWG copper wire/ GI wire.

d. All three phase switches/ DBs above 30A and upto 63A shall be earthed with 2 runs of 8 SWG copper wires/ GI wires.

e. All three phase switches/DBs above 63A and upto 100A shall be earthed with 2 runs of 25x3mm Copper Strip/GI Strip.

f. All three phase switches/DBs of 200A rating and above shall be earthed with 2 runs of 25x6mm copper Strip / GI Strip.

g. All motor frames shall be earthed by two earthing conductors of specified cross section.

Earth conductors shall be properly terminated with bolts to the frames of panels/eqpts. And provided with crimped sockets in case of wires.

1.2.2 Main earth bus shall be taken from the main medium voltage panel to the earth electrodes. The number of electrodes required shall be arrived at taking into consideration the anticipated fault on the medium voltage net-work and soil resistivity.

1.2.3 All the sub mains and sub circuits shall be provided with earth continuity conductors as specified and connected to the main earth bus. Earthing conductors for equipment shall be run from the exposed metal surface of the equipment and connected to a suitable point on the sub main or main earthing bus. All switches shall be connected through double earthing conductor to the earth bus. Earthing conductors shall be terminated at the equipment using suitable lugs, bolts, washers and nuts.

1.2.4 All conduits, cable armouring, raceway, rising mains, etc. shall be connected to the earth all along their run by earthing conductors of suitable cross sectional area, sprinkler, pipes, LPG pipes, water pipes, steel structural elements, cable trays/ racks lighting conductors shall not used as a means of earthing an installation. The electrical resistance of earthing conductors shall be low enough to permit the passage of fault current necessary to operate a fuse/ protective device a circuit breaker and shall not exceed 2 ohms. As rough guide the following sizes of earth continuity conductors shall be used for circuit wiring.

<table>
<thead>
<tr>
<th>Size of circuit wires/ cables</th>
<th>Size of copper or GI earth wires</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. 2.5 sq.mm.</td>
<td>16 SWG or 1.5sq.mm. Cu. PVC insulated</td>
</tr>
<tr>
<td>b. 4 sq.mm.</td>
<td>14 SWG or 2.5sq.mm. Cu. PVC insulated</td>
</tr>
<tr>
<td>c. 6 sq.mm.</td>
<td>12 SWG or 2.5sq.mm. Cu. PVC insulated</td>
</tr>
<tr>
<td>d. 10 sq.mm./ 16 sq.mm.</td>
<td>8 SWG or 4.0sq.mm. Cu. PVC insulated</td>
</tr>
<tr>
<td>e. 25 sq.mm. / 35 sq.mm.</td>
<td>6 SWG or 6.0sq.mm. Cu. PVC insulated</td>
</tr>
</tbody>
</table>
All Single phase wiring have one run of earth wire and three phase wiring shall be provided with two runs of earth wires.

1.4 **PRECAUTIONS**:

1.4.1 Earthing system shall be mechanically robust and the joints shall be capable of retaining low resistance even after passages of fault currents.

1.4.2 Joints shall be soldered, tinned and double rivertted in case of copper and joints shall be filed and doubled rivertted in case of GI. All the joints shall be mechanically, electrically, continuous and effective.

1.5 **TESTING**:

1.5.1 On the completion of the entire installation, the following tests shall be conducted.

a. Earth resistance of electrodes.
b. Earth loop impedance as per IS L 3043/NEC.

1.5.2 All meters, instruments and labour required for the tests shall be provided by the contractor. The results shall be submitted in triplicate to the engineer-in-charge for approval.

5.13 **Other Components**

5.13.1 **Moulded Case Circuit Breaker (MCCB)**

The MCCB (moulded case circuit breaker) shall conform to the latest IEC 947-2 & IEC 947-3–1989. The Service Short Circuit Breaking Capacity (Ics at 415VAC) should be as specified at the required level.

The MCCB shall be Current Limiting type and comprise of Quick Make – Break switching mechanism, preferably Double Break Contact system, arc extinguishing device and the Tripping unit, contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses. All MCCBs shall be capable of defined Variable overload adjustment. All MCCBs rated 200Amps and above shall have adjustable Magnetic short circuit pick up.

The trip command shall over ride all other commands. The MCCB shall employ maintenance free double break contact system to minimize the let thru 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 thru energy curves. The MCCB shall not be restricted to Line/ Load connections.

The handle position shall give positive indication of ‘ON’, ‘OFF’ or ‘Tripped’ thus qualifying to Disconnection as per the IEC947-3 indicating the true position of all the contacts. In case of 4 pole MCCB the neutral shall be defined and capable of offering protection. **MCCBs controlling motors should be suitable for motor protection.**

5.13.2 **Miniature Circuit Breaker (MCB)**
Miniature Circuit Breaker shall comply with IEC898 – 1996. The Miniature circuit breakers (MCB) shall be quick make and break type for 230 / 415 VAC 50 Hz application with thermal magnetic releases for over current and short circuit protection. The Breaking capacity shall not be less than 10 KA at 415VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Energy Class–3). MCBs shall be classified (B,C,D as per the IEC 898 standards) as per their Tripping characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values.

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

5.13.3 Switch Fuse Units

a. High rupturing capacity fuse (HRC Fuse) shall carry ISI mark on it and shall be rated for duty as indicated on the drawing/schedule of Quantities. The rating of HRC fuse shall be as per the rating of motor/equipment. The rating of fuse shall be selected so as to provide discrimination.

a. The switch fuse units shall be three pole double break action with switched neutral. All switch fuse units shall be provided with the hinged doors duly interlocked with operating mechanism so as to prevent opening of the door when the switch is ‘ON’ position and also to prevent energizing the switch when the door is not properly secured. All contacts shall be silver plated and alive parts shall be shrouded. High rupturing capacity (HRC) fuse links shall be provided with switch fuse units and shall have rupturing capacity of not less than 31 MVA at 415 volts. All switch fuse units shall be provided with visible indicators to show that they are in ‘ON or OFF’ position. All switch units shall be of AC-23 category.

5.13.4 Motor Starter

The Motor Starter shall be a combination starter consisting of motor protection circuit breaker and suitable contactor for remote starting.

a. Motor protection circuit breaker

The motor protection circuit breaker must comply to the latest IEC 947-4 and the corresponding IS 13947-4. The motor protection circuit breaker should be suitable for AC3 duty at 415V. The motor protection circuit breaker should offer built in coordinated overload and short circuit protection. The motor protection circuit breaker should have built in single phase / phase loss preventor. The motor protection circuit breaker should offer separate ON/OFF indication and Fault signal contacts which should be wired onto the panel for indication. The motor protection circuit breaker should offer Type 2 coordination along with the contactor.

b. Contactors

The contactor should be suitable for AC3 duty at 415V and should comply to the latest IEC 947-4 and the corresponding IS 13947-4. The contactor should have minimum 10 x
IE rated making / breaking capacity as per the latest standard. The same should be suitable for Type 2 coordination along with motor protection circuit breaker. The contactor should have Class H insulation for the coil to prevent heating and to facilitate frequent start / stop function without heating.

5.13.5 Earth Leakage CB/ Residual Current CB

The ELCB/RCCB shall comply with IEC 1008. The ELCB/RCCB shall current operated independent of the line voltage. ELCB / RCCB shall work on the principle of core balance transformer. The ELCB / RCCB shall be rated for current sensitivity of a Min of 30mA and a Max of 300mA at 240 / 415VAC. The terminals shall be protected against finger contact to IP20 degree of protection. The ELCB / RCCB shall have a minimum of 20,000 electrical operations.

Testing Provision for the Earth Leakage Circuit Breaker

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 and the operating handle shall move to the "OFF" position.

5.13.6 Air Circuit Breaker (ACB):

The ACB shall conform to IEC 947-2-1989 & IS 13947 (Part –2). The Service Short Circuit Breaking Capacity shall be as specified and equal to the Short circuit Withstand Values. The ACB shall be provided for controlling the incoming supply feeder or as required and specified in schedule. Shall be available in 3 or 4 pole with modular construction, fixed or draw out, manually or electrically operated versions as specified. ACB shall be capable of providing short circuit, overload and earth fault protection (in absolute values) if required, through microprocessor based control unit sensing the true RMS values to ensure accurate measurement meeting the EMI/ EMC requirement as per the standard.

The breaker should have 3 distinct positions – SERVICE / TEST / ISOLATED within the cubicle. It should be possible to withdraw the breaker for testing with the door closed. Safety interlock must be provided to prevent the ACB from falling out in a fully withdrawn position. The ACB shall be provided with a door interlock. The contacts should be copper and silver plated only with a feature of contact wear inspection indicating the life of the contacts. The ACB shall have double insulation (Class-II) with moving and fixed contacts totally enclosed for enhanced safety and inaccessibility to live parts.

All electrical closing of breaker should be with Electrical motor wound stored energy spring closing mechanism with Mechanical indicator to provide. ON/ OFF status of ACB.

For all ACBs the Operating handle should be provided for charging the spring in continuous action. The spring shall be released with ON / OFF push button command in one operation at the correct speed independent of operator speed. A direct mechanical coupling should indicate the ACB in ON or OFF position thus qualifying to Disconnection as per the IS/IEC indicating the true position of all the contacts. One set of NO / NC potential free contacts to be provided for operation on Building Management System. All accessories like shunt, under voltage motorized mechanism etc shall be front mounted, requiring no adjustments and can be fitted at site.
The manufacturer shall provide details of opening time and deration with temperature to ensure discrimination and proper selection for feeders protection. All ACBs of 4000 A and above shall be a single ACB and Tandem operated will not be acceptable.

5.13.7 SAFETY FEATURES :

1. The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.
2. It should not be possible to interchange two circuit breakers of two different thermal ratings.
3. There should be a provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism.
4. Earthing bolts must be provided on the cradle or body of fixed ACB. Arc Chute covers should be provided wherever necessary.
5. The incoming panel accommodating ACB shall be provided with indicating lamps for ON-OFF positions, voltmeter and ammeter of size not less than 96mm x 96mm, selector switches, fuses for potential circuit and current transformers.
6. It should 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.

5.13.8 PROTECTIONS

1. The Electro magnetic and thermal release or Microprocessor based unit should be provided on circuit breaker for short circuit, over current and earth fault protection with adjustable settings.
2. Specific LED indications should be provided for over current and earth fault operation.
3. Relays should be CT operated through shunt trip for short circuit and earth fault protection.
4. Under voltage relays should be provided.
5. Minimum 6 NO and 6 NC auxiliary contacts shall be provided on each breaker. The contacts shall be rated 5 Amps.
6. Rated insulation voltage is 1000 volts AC.

5.13.9 Push Button Stations

Push button stations shall be provided for manual Start & Stop of equipment. Push button shall have ON & OFF indicating lamp in red and green colour. Push button shall be fabricated in 16 gauge sheet steel.

These station shall be factory fabricated. ON & OFF operations shall be carried out from front without opening the door. One set of NO & NC contact shall be provided in push button station as spare.

5.13.10 Toggle Switch

The toggle switch shall be of minimum 5 Amps rating.

5.13.11 Thermal Overload
The relay shall be factory calibrated, sealed and suitable for an ambient temperature at site or 50 deg C whichever is higher.

It should provide reliable and accurate protection against overload, single phasing and locked rotor conditions. Relays are to be provided with:

(a) Trip alarm contact  
(b) Trip lever for testing  
(c) Auto reset facility

Rated insulation voltage shall be 660 volts AC.

5.14 **Instruments**

a. **General**:

The specifications hereinafter laid down shall cover all the meters and instruments.

b. **Instrument Transformers**

(i). **Current Transformers**

Current transformers shall be in conformity with IS : 2705 (Part I,II,III & IV) in all respects. All current transformers used for medium voltage applications shall be rated for 1 KV. However, the rated secondary current shall be 5 A unless otherwise specified. The acceptable minimum class of various applications shall be as given below:

Measuring : Class 0.5 to 1  
Protection : Class 10 p

Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault of 35 MVA on medium voltage system. Terminals of the current transformers shall be marked permanently for easy identifications of poles. Current transformers shall be provided with earthing terminals, for earthing chassis frame work and fixed part of the metal casing (If any). Each CT shall be provided with rating plate indicating the following:

i. Name and make  
ii. Serial Number  
iii. Transformation Ratio  
iv. Rated Burden  
v. Rated Voltage  
vi. Accuracy Class

Current transformers shall be mounted such that they are easily accessible for inspection, maintenance and replacement. The wiring for CT’s shall be copper conductor, PVC insulated wires with proper termination lugs and wiring shall be
bunched with cable straps and fixed to the panel structure in a neat & clean manner.

c. **Potential Transformers**

Potential transformers shall be provided if specifically called for potential transformers shall comply with the requirements of IS : (Part I,II,III) in all respects.

d. **Measuring Instruments**

i. **General**

Direct reading electrical instruments shall be in conformity with IEC-51, BS:89 or IS :1248. The accuracy of direct reading shall be 1.0 for voltmeters and 1.5 for ammeters. Other type of instruments shall have accuracy of 1.5. The meters shall be suitable for continuous operation between -10 deg C and +50 deg C. All meters shall be of flush mounting type with square pattern. The meter shall be enclosed in a dust tight housing. The meters shall be provided with white dials and black scale markings. The pointer shall be black in colour and shall have zero position adjustment device which could be operated from outside.

ii. **Ammeters**

Ammeters shall be of moving-iron type. The moving part assembly shall be with jewel bearings. The jewel bearing shall be mounted on a spring to prevent damage to pivot due to vibrations and shocks. The ammeters shall be manufactured and calibrated as per the latest edition of IS: 1248 or BS:89. Ammeters shall be instrument transformer operated, and shall be suitable for 5 A secondary.

Upto 30 Amps the ammeter shall be direct operated without current transformer on one phase only. Beyond 30 Amps the ammeter shall be CT operated with selector switch.

iii. **Voltmeters**

Voltmeters shall be of moving-iron type. The range for 400 volts, 3 phase voltmeters shall be 0 to 500 volts. The voltmeter shall be provided with protection fuse of suitable capacity.

5.15 **Earthing**

a. **General**

All non-current carrying metal parts of the electrical installation shall be earthed as per IS-3043. All metal conduits, trunking, cable sheathes, switchgear, distribution boards and all other metal parts forming part of the work shall be bonded together and connected by two separate and distinct conductors to control panel. Earthing shall meet the requirements of IER 1956.
b. **Earthing Conductor**

All earthing conductors shall be of high conductivity copper as specified and shall be protected against mechanical damage and corrosion. The size of the earth conductor shall not be less than half of the largest size of the current carrying conductor. The connection of the earth continuity conductor of earth and earth electrodes shall be strong and sound and shall be rigidly fixed to the walls, cable trenches, cable trays or conduits and cables by using suitable clamps made of non ferrous metals. Incoming power supply along with earthing upto MCC/AHU control panel shall be provided by other agency. The panel shall be earthed to building main earthing. The motor shall be double earthed to the panel.

The earthing shall be done with wires/flat as under:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Equipment</th>
<th>Size of Earth Wire/Strip</th>
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<tbody>
<tr>
<td></td>
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<td>GI</td>
</tr>
<tr>
<td>01.</td>
<td>Motors Upto 5 HP</td>
<td>2 Nos 8 SWG</td>
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<tr>
<td>02.</td>
<td>Motors Upto 15 Hp</td>
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<td>04.</td>
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<td>2 Nos 25x6mm</td>
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<tr>
<td>05.</td>
<td>Motors above 50 HP</td>
<td>2 Nos 32x6mm</td>
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<td>Flat</td>
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</table>

Packaged unit electrical panel shall generally be wall mounted type. Above stated specifications shall also stand good where applicable. The packaged unit motor shall be double earthed with two independent earth conductors as per the Indian Electricity Rules & Regulations-1956.
PREAMBLE TO BILL OF QUANTITY

1. All equipment described hereafter shall be in accordance with the specifications.

2. All equipment shall be selected and installed for the lowest operating noise level.

3. Supply of various equipment shall include all expenses for correspondence with manufacturers, submission of shop drawings, documents and their approval by the Architects, procurement of equipment, transportation, shipping, payment of all taxes and levies, storage, supply of equipment at the point of installation, furnishing all technical literature required, replacement of defective components and warranty obligations for the individual equipment.

4. Installation of various equipment shall include all material and labour associated with hoisting and lowering of equipment in position, insulation of the components and vibration isolation as required, grouting & anchoring or suspension arrangements and all incidentals associated with the installation as per the specifications and manufacturer’s recommendation.

5. Vibration isolators as specified or as recommended by the manufacturer shall be installed with each component. Performance ratings, power consumption and sound power data for each component shall be verified at the time of testing and commissioning of the installation, against the data submitted with the tenders.

6. Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirit, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop painted surfaces.

7. Testing and commissioning shall include furnishing all labour, materials, equipment, instruments and incidentals necessary for complete testing of each component as per the specifications & manufacturer’s recommendations, submission of test results to the Owners/Architects, obtaining their approval and submission of necessary completion documents & drawings. Providing minor dressing of walls and floor, providing and installing pipe sleeves as required and treatment to pipes as per the specifications.

8. All piping should be installed conforming to the relevant Indian Standards, approved shop drawings and the specifications. All water/refrigerant re- circulation piping should be tested as per the specifications.

9. Piping installation should include all costs towards supplying and fixing of pipes and fittings (elbows, tees, reducers) cutting, threading, joining, welding, soldering and affecting connections are required, providing non- hardening sealing material as well as rubber gaskets for screwed flanges, providing and installing adequate number of clamps, hangers, saddles, brackets, rawl plugs and other accessories for pipe supports, providing minor dressing of walls and floor, providing and installing pipe sleeves as required and treatment to pipes as per the specifications.

10. After completion of the installation, the entire piping system shall be tested for leak in accordance with the specifications.

11. All ducts shall be fabricated and installed conforming to the relevant Indian Standards, approved shop drawings and the specifications.
12. Duct installation shall include fabricating and installing the ducts, splitter dampers, turning 
vanes, distribution grids within the ducts in position extruded aluminium hardware fittings such 
as handles thunder bolts hinges, factory fabricated access door and providing , installing , MS 
hangers with dash fasteners, foam rubber insertions, nuts, bolts and screws as required. Making 
all joints air tight using rubber insertions in addition multi-louvered manually adjustable dampers 
shall be provided in various branch ducts as required or shown on drawings for proper balancing 
of air flow. All primer coated MS hangers, dampers, base frames etc. shall be painted with black 
enamel paint.

13. Grilles and diffusers shall be provided with a soft continuous rubber gaskets between their 
periphery and the surface on which these have to be mounted.

14. Grilles and diffusers shall be given, at the factory, a rust resistant primer coat and enamel paint 
finish of approved color. Aluminium grilles and diffusers shall be fabricated out of extruded 
aluminium sections.

15. After completion of the installation, the entire air distribution system shall be tested for leaks and 
balanced in accordance with the specifications.

16. All equipment and material to be supplied under this contract shall be conforming to the relevant 
latest Indian Standards and international standards as applicable.

17. Appropriate troughs in the suspended ceiling be provided for terminating duct collars for 
diffusers and grilles by other agencies to achieve desired interior finishes.

18. Contractor to verify the static pressure of various air handling units in accordance with the 
approved for construction shop drawings before selection of motor.

19. **Mode of Measurement**

The mode of measurement for the various items, unless otherwise specified, shall be as follows:

19.1 **Ducting**

Payment for ducting shall be made on the basis of the external surface area of the ducting 
including all material and labour for installed duct.

The rates per Sft of the external surface shall include MS angle iron /GSS flanges, gaskets for 
joints, nuts & bolts, duct supports & hangers, vibration isolation pads or suspenders, dash 
fasteners, inspection doors, dampers, turning vanes, major hardwares such as thunder 
bolts, hinges, handles in extruded aluminium construction and any other item which will be 
required to complete the duct installation except external insulation and acoustic lining.

The external area shall be calculated by measuring the overall width and depth (including the 
corner joints) in the centre of the duct sections and overall length of each duct section from 
flange face incase of duct lengths with uniform cross section. Total area will be arrived at by 
adding up the areas of all duct sections.

In case of taper pieces average width and depth will be worked out as follows:
W1 = width of small cross section
W2 = width of large cross section
D1 = depth of small cross section
D2 = depth of large cross section

Average width = \( \frac{W1 + W2}{2} \)
Average depth = \( \frac{D1 + D2}{2} \)

Width and depth in the case of taper pieces shall be measured at the edge of the collar of the flange for duct sections fitted with angle iron flanges, otherwise at the bottom of the flange where flanges are of duct sheet.

For the circular pieces the diameter of the section mid-way between large and small diameters shall be measured and adopted as the mean diameter for calculating the surface at the taper piece.

For the face length of taper piece shall be the mean of the lengths measured face to face from the centre of the width and depth of flanges.

For the special pieces like bends, branches, and tees etc. same principle of area measurement as for linear lengths shall be adopted except for bends and elbows, the length of which shall be the average of the lengths of inner and outer periphery along with curvature or angle of the piece.

19.2 Duct Insulation

This item is provided separately for various thickness and shall be paid for on area basis of uninsulated duct. The area of the duct to be insulated shall be measured before application of insulation.

19.3 Grilles & Diffusers

All extruded aluminium grilles and diffusers shall be paid on the basis of actual measurement at site on area basis using neck size as base for diffusers having outer size less than 600mm. For 600mm x600mm size diffusers being installed in grid ceiling, shall be counted at site and payment shall be made on unit basis. Slot diffusers shall be paid on actual measurement at site on running length basis. Minimum area of grilles/diffusers shall be chargeable as 0.1 SqM.

19.4 Refrigerant Piping

Payment for refrigerant piping and condensate drain piping shall be made on the basis of linear measurement including all material and labor for installed pipes. The linear rate per meter/feet for each nominal diameter shall include all pipe fittings except refnet joints, pipe supports & hangers, vibration isolation arrangement, closed cell elastomeric insulation material and any other item required to complete the pipe installation except valves of any kind and strainers.

19.5 Refnet Joints

Payment shall be made on unit basis.

20. All quantities reflected in the schedule are for contractor’s guidance only.
GUARANTEE PROFORMA FOR HVAC INSTALLATION

Owner : STPI
Location : GORAKHPUR

1. The Contractor shall furnish the following guarantee:

“We warrant that everything supplied by us including all components fitted into the equipment manufactured by others also, shall be in all respects free from all defects and faults in material, workmanship and manufacture and shall be of the highest grade and quality to acceptable standards for all materials of the type ordered and shall be in full conformity with all the specifications, drawings or samples if any and we shall be fully responsible for its efficient performance. This guarantee shall survive inspection for acceptance and payment for the equipment and installation, but shall expire (except in respect of the complaints notified to us) 12 months from the date of issue of completion certificate by the Architect/Consultants. The complaints, workmanship, manufacturer or performance of any of the equipment or part/parts thereof shall be notified by fax within 12 months from the date of issue of such completion certificate”.

2. The Contractor shall replace such of these parts which require replacement under these conditions free of cost, charge and expenses to the purchaser. In addition, the Contractor shall be responsible for a period of 12 months from the date of issue of completion certificate for any defect that may develop or appear under the conditions provided by the Contractor or use thereof arising from faulty material design or workmanship in the equivalent or any part thereof or faulty installation of the equipment by the Contractor but not otherwise and shall correct such defects within one week from the date of notification at his own cost when called upon to do so by the purchaser who shall state in writing in what respect the portion is faulty.

3. Any faulty component replaced or renewed under the clause shall also be guaranteed for a period of six months from the date of such replacement or removal of until the end of the above mentioned period whichever is later.

4. If defects are not rectified within a reasonable time as mentioned in the written notice, the Project Managers/Architects/Owners shall proceed to do so at the Contractor’s risk and cost without prejudice to any other right thereof.

SIGNATURE AND STAMP OF THE CONTRACTOR

DATE :

**************************
TECHNICAL DATA TO BE FILLED UP BY THE VENDORS AND TO BE SUBMITTED ALONG WITH THE OFFERS

VARIABLE REFRIGERANT VOLUME SYSTEM

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Item</th>
<th>Particulars</th>
</tr>
</thead>
</table>

1. **Outdoor Units**
   1.1 Manufacturer
   1.2 Country of Origin
   1.3 Type of Unit
   1.4 Model and No. of Units
   1.5 Overall Dimensions (mm)
   1.6 Noise Level (dB) at 1M distance
   1.7 Whether Night time quiet operation feature adopted
   1.8 Operating Weight (Kg)
   1.9 Material of casing
   1.10 Type of finish
   1.11 Cooling Capacity (HP)
   1.11.1 Nominal
   1.11.2 Actual
   1.12 Power consumption of overall unit at 35C ambient (KW)
   1.13 Power consumption of overall unit at 43.3C ambient (KW)
   1.13.1 Running Current drawn (Amp)
   1.13.1 Starting Current drawn (Amp)
   1.14 Recommended Incomer switch rating (Amp)
   1.15 Recommended Aluminium cable size
   1.16 Vibration isolation arrangement
   1.17 COP of overall unit
   1.18 Maximum allowable actual piping length (M)
   1.19 Maximum Level Difference (M)

2. **Compressor**
   2.1 Manufacturer
   2.2 Country of origin
   2.3 Type and number of compressor/s
   2.4 Model No.
   2.5 Nominal capacity
   2.6 Suction Temperature
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Item</th>
<th>Particulars</th>
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<td>Discharge Temperature</td>
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<td>2.8</td>
<td>Actual capacity at above parameters</td>
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<tr>
<td>2.9</td>
<td>Type of refrigerant</td>
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<td>Type of capacity control</td>
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<td>2.12</td>
<td>Power consumption (KW)</td>
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<td>Number of Fixed Speed Type Compressors</td>
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<td>Power consumption at rated capacity</td>
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<td><strong>Air Cooled Condenser</strong></td>
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<td>3.2</td>
<td>Type of condenser</td>
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<td>3.3</td>
<td>Tube material</td>
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<td>3.4</td>
<td>Fin material</td>
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<td>Coil face velocity (FPM)</td>
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<td>3.6</td>
<td>Type of fans</td>
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<td>Number of fans</td>
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<td>3.8</td>
<td>Motor rating of each fan</td>
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<td>3.9</td>
<td>Static Pressure of each fan (mmWG)</td>
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<td><strong>Indoor Units</strong></td>
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<td>4.2</td>
<td>Country of Origin</td>
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<td>Type of Unit</td>
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<td>Airflow Min/Max (Cfm)</td>
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<td>Cooling Capacity (TR)</td>
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<td>4.9</td>
<td>Operating Weight (Kg)</td>
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<td>4.10</td>
<td>Is remote controller provided with each unit</td>
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<td>4.11</td>
<td>Type of remote controller provided</td>
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<td>Power Characteristics (3Ph/1Ph)</td>
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<td>5.3</td>
<td>Type of Controller</td>
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</table>
5.4 Salient Features

6 **Refrigerant Piping**
6.1 Material of piping
6.2 Material of Fittings

**SPLIT UNITS**

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<td>Type and number of compressor/s</td>
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<td>Nominal capacity</td>
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<td>Suction Temperature</td>
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<td>Discharge Temperature</td>
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<td><strong>Condenser</strong></td>
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<td>Fan Outlet Velocity</td>
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**PRECISION AIR CONDITIONING UNITS**

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<td>Unit Model No.</td>
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<td>Type of Unit</td>
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<td>Nominal capacity of machine</td>
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<td>Overall Dimensions of indoor unit (mm)</td>
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<td>Noise Level</td>
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<td>Material of casing</td>
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<td>Thickness of inner skin (mm)</td>
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<td>1.16</td>
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<td>1.17</td>
<td>Insulation material &amp; thickness of drain pan</td>
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<td>Power consumption of overall unit (KW)</td>
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<tr>
<td>a.</td>
<td>Compressor/s</td>
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<td>b.</td>
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<td>c.</td>
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<td>2.3</td>
<td>Type and number of compressor/s</td>
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<tr>
<td>2.4</td>
<td>Model No</td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>Nominal capacity</td>
<td></td>
</tr>
<tr>
<td>2.6</td>
<td>Suction Temperature</td>
<td></td>
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<tr>
<td>2.7</td>
<td>Discharge Temperature</td>
<td></td>
</tr>
<tr>
<td>2.8</td>
<td>Actual capacity at above parameters</td>
<td></td>
</tr>
<tr>
<td>2.9</td>
<td>Type of refrigerant</td>
<td></td>
</tr>
<tr>
<td>2.10</td>
<td>Power consumption (KW)</td>
<td></td>
</tr>
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<td>2.11</td>
<td>Type of Protection</td>
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</tr>
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<td>3.</td>
<td>Condenser</td>
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</tr>
<tr>
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<td>Manufacturer</td>
<td></td>
</tr>
<tr>
<td>3.2</td>
<td>Type of condenser</td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>No. of units with each module of PAC units</td>
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</tr>
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<td>3.4</td>
<td>Entering air temperature (C)</td>
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<tr>
<td>3.5</td>
<td>Leaving air temperature (C)</td>
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<td>3.6</td>
<td>Type of fan</td>
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<tr>
<td>3.7</td>
<td>No. of fans</td>
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</tr>
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<td>3.8</td>
<td>Type of motor</td>
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</tr>
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<td>3.9</td>
<td>Motor Rating</td>
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<tr>
<td>3.10</td>
<td>Overall Dimensions of remote condenser (mm)</td>
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<td>4.</td>
<td>DX - Cooling Coil</td>
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<td>Type of cooling coil</td>
<td></td>
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<tr>
<td>4.3</td>
<td>Tube material</td>
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</tr>
<tr>
<td>4.4</td>
<td>Fin material</td>
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<td>4.5</td>
<td>Coil face velocity (FPM)</td>
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<tr>
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<td>Coil face area (SqM)</td>
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<td>Centrifugal Fan</td>
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</tr>
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<td>Type of fan</td>
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</tr>
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<td>Model No.</td>
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<td>5.4</td>
<td>Air Quantity. (Cfm)</td>
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<td>Static Pressure ESP/TSP (mm WG)</td>
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<td>5.6</td>
<td>Fan Outlet Velocity</td>
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<td>5.7</td>
<td>Fan input Power (KW)</td>
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<td>Type</td>
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<tr>
<td>6.3</td>
<td>Rating (HP)</td>
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<td>6.4</td>
<td>Speed (RPM)</td>
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<td>6.5</td>
<td>Electrical Characteristics</td>
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<td>6.6</td>
<td>Whether EC motor provided</td>
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<tr>
<td>S. No.</td>
<td>Item</td>
<td>Particulars</td>
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<td>7.</td>
<td>Filters</td>
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</tr>
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<td>7.2</td>
<td>Type</td>
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<td>7.3</td>
<td>Thickness (mm)</td>
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<td>Filter Face Velocity</td>
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<td>Humidifier</td>
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<tr>
<td>8.2</td>
<td>Type</td>
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<tr>
<td>8.3</td>
<td>Capacity (Kg/Hr)</td>
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<td>8.4</td>
<td>Input Current (A)</td>
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<td>8.5</td>
<td>Operating Voltage</td>
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<td>8.6</td>
<td>Cleaning Action</td>
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<td>8.7</td>
<td>Water supply pressure range (kPa)</td>
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<td>8.8</td>
<td>Drain connection (mm)</td>
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<td>8.9</td>
<td>Connection supply (BSP Female)</td>
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<td>9.</td>
<td>Electrical Strip Heaters</td>
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</tr>
<tr>
<td>9.2</td>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>9.3</td>
<td>Quantity / No. of stages</td>
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<td>9.4</td>
<td>Material of sheath</td>
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<td>9.5</td>
<td>Material of fins</td>
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<td>Power Rating (KW)</td>
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<td>9.7</td>
<td>Type of Protection</td>
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<td>8.</td>
<td>Controls</td>
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<td>8.2</td>
<td>Type</td>
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**INLINE FANS**

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<td>Type</td>
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<tr>
<td>1.3</td>
<td>Electrical Characteristics</td>
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<td>1.4</td>
<td>Whether Capacitors Provided</td>
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<td>Whether speed regulators Provided</td>
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<td>1.6</td>
<td>Whether gravity louvers and bird screen provided</td>
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**REFRIGERANT PIPING**

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<td>1.</td>
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### DUCT WORK

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</tr>
<tr>
<td>1.1</td>
<td>Manufacturer of GI Sheet</td>
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</tr>
<tr>
<td>1.2</td>
<td>Class</td>
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</tr>
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<td>1.3</td>
<td>Zinc coating (gm/SqM)</td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>Thickness</td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>Manufacturer of Factory Fabricated Ducts</td>
<td></td>
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<tr>
<td>1.6</td>
<td>Type of flanges for factory fabricated ducts</td>
<td>For Exposed Ducts For Concealed Ducts</td>
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</table>

### GRILLES, DIFFUSERS AND DAMPERS

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<tr>
<th>S.No.</th>
<th>Item</th>
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<tbody>
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<tr>
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<td>Manufacturer</td>
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### ACOUSTIC LINING OF DUCT

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<tbody>
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<td>Manufacture</td>
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<tr>
<td>1.3</td>
<td>Density</td>
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<td>1.4</td>
<td>Thickness</td>
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<td>1.5</td>
<td>Thermal Conductivity (K Value)</td>
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### EXTERNAL THERMAL INSULATION OF DUCTS

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<th>Item</th>
<th>Particulars</th>
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<tbody>
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<td>Material</td>
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<td>1.2</td>
<td>Manufacture</td>
<td></td>
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<tr>
<td>1.3</td>
<td>Density</td>
<td></td>
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<td>1.4</td>
<td>Thickness</td>
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<td>1.5</td>
<td>Thermal Conductivity (K Value)</td>
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<td>Class of insulation</td>
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### EXPOSED DUCT THERMAL INSULATION

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<th>S.No.</th>
<th>Item</th>
<th>Particulars</th>
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### General

1.1 Manufacturer
1.2 Material
1.3 Density
1.4 Thickness

### ELECTRICAL

<table>
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<td>1.</td>
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<tr>
<td>1.1</td>
<td>Manufacturer of panels</td>
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<td>1.2</td>
<td>Make of following components</td>
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<td>1.2.1</td>
<td>MCCB</td>
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<td>1.2.2</td>
<td>MCB</td>
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<td>1.2.3</td>
<td>Starters</td>
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<td>1.2.4</td>
<td>Ammeters/Voltmeters</td>
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<tr>
<td>1.2.5</td>
<td>Push Buttons</td>
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<td>1.2.6</td>
<td>Indication Lights</td>
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<td>1.2.7</td>
<td>Current Transformers</td>
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</tr>
<tr>
<td>1.3</td>
<td>Power Cables</td>
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<tr>
<td>1.4</td>
<td>Control Cables</td>
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</tr>
<tr>
<td>1.5</td>
<td>Stabilisers</td>
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**************************************************
### APPROVED MAKES OF EQUIPMENT & MATERIALS

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<tr>
<th>S. No.</th>
<th>EQUIPMENT AND MATERIAL</th>
<th>ACCEPTABLE MAKE</th>
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<tbody>
<tr>
<td><strong>A.</strong></td>
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<tr>
<td>1.</td>
<td>VRV System</td>
<td>Daikin /Toshiba/ Mitsubishi-Electric/ Samsung/ Bluestar</td>
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<td>2.</td>
<td>HRV System</td>
<td>Daikin /Toshiba/ Mitsubishi-Electric/ Samsung/ Bluestar</td>
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<tr>
<td>3.</td>
<td>Ductable &amp; Non-Ductable Split Units</td>
<td>Daikin/Toshiba /Mitsubishi/Carrier</td>
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<tr>
<td>4.</td>
<td>Compressor for Split Units</td>
<td>Daikin/Toshiba/Mitsubishi/Carrier</td>
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<td>5.</td>
<td>Precision packaged type air conditioning units</td>
<td>Blue Box/ Stulz</td>
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<tr>
<td>6.</td>
<td>Compressors</td>
<td>Copeland/Danfoss</td>
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<tr>
<td>7.</td>
<td>EC Fan</td>
<td>EBM</td>
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<tr>
<td>8.</td>
<td>Centrifugal Fans for AHUs, Extract Fan Sections or wherever</td>
<td>Nicotra/ Kruger/Comefri</td>
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<tr>
<td>9.</td>
<td>Variable Frequency Drives</td>
<td>Danfoss/ ABB/ Siemens</td>
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<tr>
<td>10.</td>
<td>Voltage Stabilisers</td>
<td>Logicstat</td>
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<tr>
<td>11.</td>
<td>Motor</td>
<td>ABB/ Siemens/Bharat Bijli</td>
</tr>
<tr>
<td>12.</td>
<td>V-Belts</td>
<td>Fenner India/ Dunlop</td>
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<tr>
<td>13.</td>
<td>Inline Fans</td>
<td>Sphere Vent/ Tristar</td>
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<tr>
<td>14.</td>
<td>Propeller Fans</td>
<td>Alstom Marathon</td>
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<tr>
<td>15.</td>
<td>Vibration isolators/ suspenders</td>
<td>Resistoflex</td>
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<td>16.</td>
<td>Air curtain</td>
<td>Beacon/Thermadyne/ Tristar</td>
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<tr>
<td>17.</td>
<td>Pressure/Temperature &amp; RH Sensor</td>
<td>Honeywell/Siemens-Staefa/Johnson</td>
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<tr>
<td><strong>B.</strong></td>
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</tr>
<tr>
<td>1.</td>
<td>Pipes (MS &amp; GI)</td>
<td>Tata Steel/ Jindal (Hissar)</td>
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<td>2.</td>
<td>cPVC/uPVC Piping</td>
<td>Poly Pack/Astral/Supreme</td>
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<td>3.</td>
<td>Copper Refrigerant Piping</td>
<td>Rajco/Mandev /Jindal</td>
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<td>4.</td>
<td>Drain/Copper Refrigerant Piping Insulation (Closed Cell Elastomeric Insulation)</td>
<td>K Flex/Armacell</td>
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<tr>
<td>5.</td>
<td>Welding Rods</td>
<td>Advani</td>
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<td><strong>C.</strong></td>
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<tr>
<td>1.</td>
<td>GS Sheet</td>
<td>SAIL/Tata Steel/National/Jindal/Lloyd</td>
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<td>Factory Fabricated Ducts &amp; TDC flanges</td>
<td>Ductofab/Dustech/Zeco</td>
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<td>3.</td>
<td>Round/Spiral Factory Fabricated Ducts</td>
<td>Ductofab/Dustech</td>
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<tr>
<td>4.</td>
<td>Pre Filters</td>
<td>Purolator/Thermodyne/Spectrum</td>
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<tr>
<td>5.</td>
<td>Extruded Aluminium Grilles &amp; Diffusers</td>
<td>Servex /Dynacraft/Tristar</td>
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<td>6.</td>
<td>Dash Fasteners</td>
<td>HILTI/Fischer</td>
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<tr>
<td>S. No.</td>
<td>EQUIPMENT AND MATERIAL</td>
<td>ACCEPTABLE MAKE</td>
</tr>
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<td>------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>7.</td>
<td>Intake Louvers</td>
<td>Servex/Dynacraft/Tristar</td>
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<td>8.</td>
<td>Duct /grille dampers &amp; Air Transfer Grille</td>
<td>Servex/Dynacraft/Tristar</td>
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<tr>
<td>9.</td>
<td>Zero Leakage Ex. Al dampers</td>
<td>Caryaire/Tristar/Servex</td>
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<td>10.</td>
<td>Smoke cum Fire Dampers</td>
<td>Caryaire/Tristar/Servex</td>
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<tr>
<td>11.</td>
<td>Actuators for Motorised Damper &amp; Fire Dampers</td>
<td>Belimo(Swiss), Joventa (Swiss), Siemens</td>
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<td>12.</td>
<td>Fabric for Flexible Connection</td>
<td>Sphere/Easyflex</td>
</tr>
<tr>
<td>13.</td>
<td>PLC Auto sequencers</td>
<td>Proton/Creative</td>
</tr>
<tr>
<td>14.</td>
<td>Flexible Ducts</td>
<td>UP Twiga</td>
</tr>
<tr>
<td>15.</td>
<td>Steel Wire Rope Hangers &amp; Supports</td>
<td>Gripple</td>
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**D. INSULATION**

<table>
<thead>
<tr>
<th></th>
<th>Fibre Glass</th>
<th>UP Twiga/Owens Corning/K Flex</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Closed Cell Elastomeric Insulation</td>
<td>K Flex/Armacell</td>
</tr>
<tr>
<td>2</td>
<td>Open Cell Elastomeric Insulation</td>
<td>K Flex/Armacell</td>
</tr>
<tr>
<td>3</td>
<td>Expanded Polystyrene</td>
<td>Beardsell/Toshiba/SHI</td>
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<tr>
<td>4</td>
<td>RP Tissue</td>
<td>UP Twiga/Owens Corning</td>
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<tr>
<td>5</td>
<td>Adhesive for application of closed cell insulation (AC Duct King Eco Fresh &amp; 1K PUR FR)</td>
<td>Fevicol/Pidilite/Foster</td>
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<td>6</td>
<td>Glass cloth &amp; UV protection paint</td>
<td>Paramount/Armaflex</td>
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<tr>
<td>7</td>
<td>Nitrile Tape for nitrile insulation (Class ‘O’)</td>
<td>K Flex/Armacell/Eurobatex</td>
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**E. ELECTRICAL**

<table>
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<th>Panel Manufacturers</th>
<th>NK Electricals/ Madhu Electricals/ Tricolite/ Advance/Indiatech</th>
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<tr>
<td>Components</td>
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<td>1</td>
<td>MCCB</td>
<td>L&amp;T/ABB/Siemens/GE power/Merlin Gerin</td>
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<td>2</td>
<td>MCB</td>
<td>L&amp;T/Hager/Merlin Gerin/MDS</td>
</tr>
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<td>3</td>
<td>ELMCB/ELCB</td>
<td>L&amp;T/Hager/Merlin Gerin/MDS</td>
</tr>
<tr>
<td>4</td>
<td>Contractors</td>
<td>L&amp;T/GE/Siemens</td>
</tr>
<tr>
<td>5</td>
<td>Overload Relay</td>
<td>L&amp;T/GE/Siemens</td>
</tr>
<tr>
<td>Cables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Power Cables</td>
<td>Havells/Polycab/Rallison/Skytone</td>
</tr>
<tr>
<td>2</td>
<td>Copper Control Cables</td>
<td>Finolex/National/Skyline/Rallison</td>
</tr>
<tr>
<td>3</td>
<td>Cable Gland</td>
<td>Commet</td>
</tr>
<tr>
<td>4</td>
<td>Lugs</td>
<td>Dowells crimping type/3D/Jainsons</td>
</tr>
<tr>
<td>5</td>
<td>Connectors</td>
<td>Elmec/VKS/ESSEN</td>
</tr>
<tr>
<td>Meters/ Indicators</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Ammeters/Volmeters (Digital Type)</td>
<td>L&amp;T/Rishab/AE/Enercon/Secure</td>
</tr>
<tr>
<td>2</td>
<td>Indicating Lamps (LED Type)/Push Buttons</td>
<td>Siemens/ESBEE/L&amp;T</td>
</tr>
<tr>
<td>3</td>
<td>Current Transformer</td>
<td>AE/L&amp;T/EE/AVK-SEGCE</td>
</tr>
<tr>
<td>S. No.</td>
<td>EQUIPMENT AND MATERIAL</td>
<td>ACCEPTABLE MAKE</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>4.</td>
<td>Selector Switches</td>
<td>Salzer (I&amp;T), Kaycee</td>
</tr>
</tbody>
</table>

NOTES:

1. Make of any other equipment/material not mentioned above shall be got approved from the Architects/Owners before execution.

2. Relevant catalogue to be submitted along with the offers.

3. Relevant Test Certificates to be produced for various equipment & material during billing process.

4. Under electrical, wherever, there is multiple choices of brands/approved makes, the brands/make nominated by Owners/Architects out of the multiple brands shall have to be supplied.

*********************
LIST OF EQUIPMENT & ACCESSORIES WHICH CONTRACTOR HAS TO BRING, KEEP AND MAINTAIN, AT HIS OWN COST, AT SITE DURING THE CURRENCY OF THE CONTRACT IN GOOD CONDITION.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>PLANT/EQUIPMENT</th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>01.</td>
<td>Hydraulic Test Machine</td>
<td>1</td>
</tr>
<tr>
<td>02.</td>
<td>Floor mounted drill machine</td>
<td>1</td>
</tr>
<tr>
<td>03.</td>
<td>Hand drill machine</td>
<td>2</td>
</tr>
<tr>
<td>04.</td>
<td>Lock forming machine for duct fabrication</td>
<td>1</td>
</tr>
<tr>
<td>05.</td>
<td>Hand held lock closing machine</td>
<td>1</td>
</tr>
<tr>
<td>06.</td>
<td>Collar cutting machine</td>
<td>1</td>
</tr>
<tr>
<td>07.</td>
<td>Mechanized saw for cutting angles &amp; channels</td>
<td>1</td>
</tr>
<tr>
<td>08.</td>
<td>Duct smoke test kit</td>
<td>1</td>
</tr>
<tr>
<td>09.</td>
<td>Thermometers</td>
<td>2</td>
</tr>
<tr>
<td>10.</td>
<td>Water line pressure testing kit</td>
<td>1</td>
</tr>
<tr>
<td>11.</td>
<td>For application of closed cell elastomeric insulation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i. 1200 long steel scale</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ii. 1200x900 size 40mm thick commercial ply board</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>iii. Paper cutter of different sizes</td>
<td>12</td>
</tr>
</tbody>
</table>

and any other equipment required for efficient execution of work within the stipulated period.

**********************
CONSTRUCTION OF INCUBATION CENTRE FOR SOFTWARE TECHNOLOGY
PARK OF INDIA (STPI)

AT

PLOT NO. 4&5, SECTOR-7, GIDA, GORAKHPUR

VOLUME – 2, Part - II

(ELECTRICAL WORKS)
1. **Scope of work for Internal & External Electrical Works**

1. GENERAL SPECIFICATION FOR ELECTRICAL WORK
2. VACUUM CIRCUIT BREAKERS 11 KV
3. GENERAL SPECIFICATION FOR: OIL TYPE DISTRIBUTION TRANSFORMERS (11KV)
4. HIGH TENSION CABLE (XLPE) 11KV / 22KV /33KV
5. L. T. PANELS (POWER CONTROL CENTERS & SWITCH BOARD PANELS)
6. AIR CIRCUIT BREAKERS
7. MOULDED CASE CIRCUIT BREAKERS
8. METERING, INSTRUMENTATION AND PROTECTION
9. POWER FACTOR IMPROVEMENT SYSTEM
10. MEDIUM VOLTAGE CABLES
11. MEDIUM DISTRIBUTION BOARDS
12. MEDIUM VOLTAGE DISTRIBUTION SYSTEM
13. EARTHING FOR ELECTRICAL WORK
14. LIGHTNING PROTECTION SYSTEM
15. GENERAL SPECIFICATION FOR LIFE SAFETY & FIRE ALARM SYSTEM
GENERAL SPECIFICATION FOR ELECTRICAL WORK:

1. **SCOPE**

In general, the contractor shall supply, store, erect, test and commission all the equipment required for Electrical Installation. The contractor shall provide all the materials, labour, tools and equipments required for the electrical work, as shown in the accompanying drawings and in the schedule of quantities and specifications hereinafter described.

2. **CONTRACTOR**

The Contractor shall be a licenced electrical contractor, possessing a valid electrical contractor's license in the state of Rajasthan, employing licensed supervisors and skilled workers having valid permits as per the Regulation of Indian Electricity Rules and Local Electrical Inspector’s requirements. (In case the contractor does not have licence of that state then it should be clearly stated by local electrical contractor, the contractor shall submit the test report & a copy of the valid licence of the contractor along with the copy of their own licence of the state of their registration).

3. **DEFINITIONS**

The following abbreviations used in the bill of quantities specifications and drawings represents :

- **ISS** - Indian Standard specification.
- **IER** - Indian Electricity Rules, 1956.
- **BS** - British Standard (where specifically called for)
- **BSCP** - British Standard Code of Practice (if called for).
- **HRC** - High Rupturing Capacity
- **GI** - Galvanised Iron
- **MS** - Mild Steel
- **CI** - Cast Iron
- **APLSTS** - Aluminium conductor, paper insulated lead sheathed, Double steel tape armoured and serving.
- **PVC** - Polyvinyl Chloride.
- **XLPE** - Cross Linked Polyethylene.
- **HT** - High Tension.
LT - Low Tension.
A-Amp - Ampere.
KV - Kilo Volts.
PT - Potential Transformers.
CT - Current Transformers.
OCB - Oil circuit Breakers
VCB - Vacuum Circuit Breaker
ACB - Air Circuit Breakers
SFU - Switch fuse Unit
COS - Change Over Switch
CFS - Combination Fuse Switch
MCCB - Moulded Case Circuit Breaker.
MCB - Miniature Circuit Breaker
IC - Iron Clad
ICTPN - Iron Clad Triple Pole and Neutral
ICDP - Iron Clad Double Pole
DB - Distribution Board
KVA - Kilo Volts Ampere.
KVAR - Kilo Volts Ampere - Reactive.
NC - Normally Close
NO - Normally open
SWG - Standard Wire Gauge.

REGULATION & STANDARDS

The installation shall conform in all respects to Indian standard Code of Practice for Electrical Wiring Installation I.S. - 732 and ‘National Electrical Code’. It shall be in conformity with the current I.E Rules and Regulations and requirements of the local Electric Supply Authority in-so-far as these become applicable to the installation. Wherever this specification calls for a higher standard of materials and/or workmanship then those required by any of the above regulations, these specifications shall take precedence over the said regulations and standards.
In general, the materials, equipments and workmanship not covered above, shall conform to the following Indian Standards (Latest Edition) unless otherwise called for:

**SWITCHGEAR**

a. Requirements of A.C. Circuit Breakers. (ACBs & MCCBs) : IS 13947-1, 2/IEC 60947-1, 2

b. Switches and Switch Isolators above 1000V But Not Exceeding 1.1 KV : IS 4710

c. Markings & arrangements for switchgear bus-bars, main connection & auxiliary wiring : IS 375

d. Specification for normal duty air break switches & composite units for air break switches and fuses for voltage not exceeding 1000 Volts. : IS 4064

e. Heavy duty air-break switches and composite units of air-break switches and fuses for voltages not exceeding 1000 Volts. : IS 4047

f. Specification for miniature circuit breakers. : IS 8828

g. Specification for enclosed distribution, fuse boards and cut-outs for voltage not exceeding 1000 Volts : IS 2675

h. Installation and maintenance of switchgear. : IS 3072 (Part I)

i. HRC cartridge fuse links 650 Volts. : IS 9224

2. **CABLE**

a. Specification for XLPE insulated armoured, PVC Sheathed cables (11kV/22kV/33kV) : IS 7098 (Part-II)

b. Specification for PVC insulated (Heavy Duty) electric cables for Voltage upto 1100 Volts : IS 1554

c. Specification for XLPE insulated cables (for voltage upto 1100 V) with Aluminium conductors. : IS 7098 (Part-I)

3. Specification for rigid steel conduit for electrical wiring. : IS 9537

4. Specifications for rigid non metallic conduits for electrical installations. : IS 9537

5. Specifications for accessories for rigid steel conduits for Electrical wiring. : IS 3837

6. Box for the enclosure of electrical accessories steel and C.I. Boxes. : IS 5133 (Part I)

7. 3Pin plugs and sockets outlets : IS 1293

8. Ceiling Roses : IS 371
9. Adhesive insulating tapes for Electrical purposes (Part I & II) : IS 2448
10. General and safety requirements for Electrical lighting fittings. : IS 1913
11. Watertight electric light fittings. : IS 3553
12. Flood Lights. : IS 1947
13. Ceiling fans and regulators. : IS 374
14. Propeller type AG Ventilating fans : IS 2312
16. Glossary of terms for electrical cable and conductors. : IS 1885
17. Code of Practice for buildings (General) Electrical installation : IS 1646
18. Protection of buildings and allied structures against lightning. : IS 2309
19. Current Transformers : IS 2705 (Part-I to III)
20. Voltage Transformer : IS 3156 (Part-I to III)
22. Installation Transformer : IS 10029
23. Shunt capacitors for Power system : IS 2834
24. Direct acting electrical indicating instruments : IS 1246
25. Factory assembled switchgear : IS 8623
26. Rating for Cable : IS 3961 (Part-I)
27. Earthing : IS 3843

6. DRAWINGS

The drawings, specifications and schedule of quantities shall be considered as a part of this contract and any work or materials shown on the drawings and not called for in the specifications or vice-versa, shall be executed as if specifically called for in both. The contract drawings indicate the extent and general arrangement of various equipment and wiring, etc. and are essentially diagrammatic. The drawings indicate the point of termination of conduit runs and broadly suggest the routes to be followed. The work shall be executed as per approved working drgs, subject to any minor changes, if found essential to co-ordinate installation of this work with other trades. All such changes shall be done without any additional major cost to the owners. The data given in the documents and drawings are approximate & their complete accuracy is not guaranteed. The drawings and data furnished are meant for guidance & assistance to the contractor. The exact dimension, location, distance and levels, etc., will be governed by the site conditions. The contractor shall examine all Architectural, structural, plumbing and sanitary and air-conditioning drawing before starting the work and report to the architect/consultant any discrepancy which in his opinion appear on them, and get the same clarified. He shall not be entitled to any extras for omissions or defects in electrical drawings or when they conflict with other work.
VACUUM CIRCUIT BREAKERS (11 KV)

1. GENERAL:

Vacuum Circuit Breakers shall be of latest state of art technology of vertical isolation horizontal drawout type. It shall be of proven design the Vacuum Circuit Breaker shall be rated for continuous current capacity at Rated System voltage.

2. SYSTEM PARAMETERS:

The Vacuum Circuit Breakers shall be suitable for the following parameters:

a. Rated System Voltage : 11KV, 50Hz, 3Phase AC.

b. Highest System Voltage : 12 KV

c. Rated Current : 630 Amp.

d. Rated breaking Capacity : 500 MVA at 11 KV

e. Rated making capacity : 46, 83KA at 11 KV

f. Power Frequency withstand : 28 KV.

g. Impulse withstand : 75 KVP

h. Opening time : less than 40 milli secs.

3. CODES & STANDARDS:

The breaker shall conform to IS 3427/IEC 298, IEC 62271-100, IEC 62271-200.

Breaker shall be fully tested as per codes/ standards a test certificate from CPPI shall be furnished.

a. Circuit breaker compartment

b. Bus bar compartment

c. CT & cable compartment

d. LT Compartment for mounting meters & instruments.
Breaker compartment shall be mounted in vertical isolation horizontal draw out truck with front plate which covers the cubicle when the breaker is in service position. The document truck shall have 'isolated'/ 'test & service' positions.

Bus bars shall be air insulated & mounted on cast epoxy insulated to withstand short current of 44 KA for 3 See.

CT & cable compartment shall be preferably located on rear side. CTS shall be epoxy insulated. Provision for terminating 2Nos. 3 core cable shall be provided. The cable entry shall be from the bottom of the panel.

4. TECHNICAL FEATURES:
The VCB shall have the following technical features:

a. VCB shall have a mech. Endurance of 50,000 to 60,000 operations.
b. VCB shall not require routine inspection upto 10,000 mech. operations or shall not require major inspection upto 30,000 mech. operations.

c. VCB shall be totally restrike free. Auto-reclosing shall be pose any problem. The dielectric strength shall be recovered fast enough to perform multiple open-close-open-operation.

d. VCB shall have negligible contact erosion even after 20,000 operations at rated current.

5. ACCESSORIES

The Vacuum Circuit Breaker shall provided the following accessories:

a. Auxiliary Switch
b. Closing Solenoid
c. Tripping Solenoid
d. Mech. Operation Counter
e. Shunt release
f. Motorised spring charging mechanism
g. Earthing switch
h. Space heaters
i. ON/OFF/TEST/ISOLATED Indicators & name plate.
j. Earth bus (copper) with earthing bolts for all VCB jointed together by bus links/bolts.

6. INSTRUMENT TRANSFORMERS:

VCB panel shall be provided with the following:

a. One 11KV/110V, 100 VA PT of epoxy cast resin
b. 3Nos. (double secondary) cast epoxy resin CTS of the following characteristics:
   
i. 15VA burden/ class 1.0 for core-1
   ii. Class 5 P10 for core-2

c. Terminal strip for all CTS/PTS & control wiring with 1.5 sq.mm. copper wiring cables.
7. **SAFETY INTERLOCKS**:

The VCBs shall have following safety & interlocking features:

a. VCB truck can't be moved when in 'ON' position.
b. VCB can't be switched 'ON' when the truck is in any position between test or service position.
c. Front part of the truck can't be removed when breaker is in 'ON' position.
d. Low voltage plug & socket can't be disconnected in any position except test/isolated position.
e. Earthing switch can't be switched 'ON' when truck is inside the panel.
f. The truck cannot be moved inside the panel when LT plug & socket is disconnected.
g. Truck can't be inserted when earthing switch is in 'ON' position.
h. Individual explosion vents for all channels on the top of the panel.
i. Self-locking safety shutters to close automatically when the truck is withdrawn to test/isolated position.

8. **METERING**

a. One 0-15 KV 96 sq. mm square voltmeter with selector switch & fuse.
b. One no. Ammeter with selector switch.
c. One Trivector meter for 3 Phase, 3wire unbalanced loads with ½ max. demand indicato.
d. One KWH meter.
e. Indicating Lamps:
   i. VCB 'closed' lamp (1 No.)
   ii. VCB 'open' lamp (1 No.)
   iii. VCB 'Autotrip' lamp (1 No.)
   iv. VCB 'Heating trip' lamp (1 No.)
v. VCB 'spring charged' lamp (1 No.)
vi. Non-trip alarm (1 No.)
GENERAL SPECIFICATION FOR: OIL TYPE DISTRIBUTION TRANSFORMERS (11KV)

1.0 GENERAL:

The power transformers shall be supplied & installed as per the requirements furnished in the equipment Schedule & bill of Quantities.

2.0 CODES & STANDARDS:

The transformers shall conform to the following codes & standards:
A. IS : 2026 (Part I to IV)
B. IS : 10028 (Part II)
C. IEC : 76

SYSTEM PARAMETERS:

The transformers shall be suitable for continuous operation at rated KVA under the following system parameters:

a. Nominal Voltage- Primary : 11,000 Volts
b. Maximum Voltage- Primary: 12,000 Volts
c. Frequency : 50 Hz
d. Frequency Variation : +/- 5%
e. Voltage variation : As/ standards

Transformer shall be able to withstand short-circuit current as per relevant standards between phases & between phase to ground with full voltage maintained at the other side without any injury to the transformer. The duration of the short circuit shall be as called for in the relevant standard (Refer IS: 2026 Part- I clause 8 & 9).

SALIENT FEATURES:

The transformer shall have the following salient features:
Transformer shall be oil immersed, natural cooled & double wound. Windings shall be made of electrolytic copper conductor. Tank shall be made of good quality low carbon steel of adequate thickness & electrically welded.

All welded joints shall be stress relived.

All access holes, manholes etc., shall be so designed as to prevent any ingress of moisture into the tank.

All gaskets shall be non-deteriorating, hot oil resistant, weather-proof & resilient type.

Tank shall not be deformed & joints shall not yield due to the system short-circuit allowable as per IS: 2026.

Transformer cores shall be of low loss, non-aging, high quality, cold reduced grain oriented silicon steel laminations.

The core fabrication shall be done in such a manner as to avoid hum & vibration and should be of boltless construction type. The core lamination insulation shall be resistant to oil & high temperature encountered.

Insulation of the winding shall be of very high quality & shall be resistant to the action of hot oil & high temperature encountered.

ACCESSORIES & FITTINGS:

The transformer shall be fitted with accessories & fittings as listed in "Equipment Schedule".

COOLING:

Transformers shall be of “ONAN” type unless otherwise called for in the equipment schedule & BOQ. Transformer shall be provided with radiators mounted directly on the tank. The oil used for insulation & cooling shall conform IS: 355 in all respects.

TAPPINGS:

Tappings shall be provided on HV winding as specified. The transformer shall be capable of operation at the rated KVA at any tap position provided the voltage variation is limited to +/- % of the voltage corresponding to the tap. The variation in impedance shall be limited a minimum over the entire range of taps.

TAP CHANGING GEAR:
Off load tap changing shall be effected by a 3-phase gang operated tap switch. The operating shaft shall be brought out of the tank & a hand wheel at a convenient height. A visual indicator to indicate the position of the tapping in use shall be provided. It shall be possible to padlock the handle in each tap position. A suitable interlock shall be provided so that padlocking is not possible unless the tapping contacts are engaged. On-load tap changing gear may be provided, if specifically called for in “Equipment Schedule” & BOQ.

CONSERVATOR:

A detachable conservator of liberal capacity & equipped with oil level indicator, drain valve, detachable cover at one end shall be provided. The conservator shall be connected to the tank with necessary piping & valves.

The following oil valves of high quality gun metal shall be provided:

- Drain valve & oil sampling valve for the tank.
- Conservator drain valve.
- Flanged valve between buchholz relay & conservator.

TERMINAL ARRANGEMENT:

HIGH VOLT CABLE CONNECTION:

i. High volt terminals of the transformer shall be brought out through side wall bushings to a cable end-box suitable for terminating 3-core 11 KV H.T. cable.

ii. Cable end box shall be self-supporting weather-proof type complete with detachable cover, suitable no. of cable entries, etc, as required.

L. T. CABLE CONNECTION:

i. 415 Volts terminals shall be brought out through side-wall mounted bushings to a cable end box with self-supporting disconnection chamber or terminal box suitable for 1100 volts, aluminum conductor, armored PVC cable < as per drawing>.

TEST:

Routine test shall be conducted on all transformers at manufacturer's works as per IS: 2026. In addition, transformer tanks shall be subjected to leak tests & vacuum tests. Original test certificate shall be furnished along with transformers.

HANDLING, STORING, INSTALLATION & COMMISSIONING:
Transformers shall be installed as per IS 10028 part- II & regulation of local authorities.

HANDLING:

Transformer & its accessories shall be handled carefully in its upright position as indicated on the packing case or as per the direction of the manufacturer. Lifting lugs & jacking pads shall be used for lifting of the transformer. Jacking pads shall be used with utmost care. Traction eyes with steel wire ropes shall be used for pulling or dragging of the transformer on sleepers or rollers.

STORAGE:

Transformer shall be stored in covered place which is free from moisture. No explosive/ inflammable materials shall be stored near the transformer. Transformer shall be covered with heavy polythene cover or any other water proof material. All gaskets shall be tightened to avoid any leakage into the transformer.

CABLING & EARTHING:

Cables shall be terminated at H. T. & L. T. sides only after IR values are measured & found to be in order. Cable terminations shall be carried out with utmost care using correct termination materials as specified in BOQ. H. T. cable termination shall be carried out in dry weather conditions. Transformer neutral shall be provided with double run of copper earth tapes & connected to 2 Nos. copper plate earth stations. Body of the transformer shall be also be provided with effective earthing by means of double run of GI earth tapes to GI plate earth station.

PRE-COMMISSIONING TESTS:

The following pre-commissioning tests shall be carried out before the transformer is commissioned:

Position & inclination of the transformer shall be checked with respect to buchholz relay.

General inspection of bolts, nuts, gaskets & accessories shall be carried out.

Dielectric strength of oil shall be got tested from three samples taken from the bottom of transformer tank.

IR Values on HV and LV windings shall be tested with 1000 V DC megger.
Voltage ratio on each step of tap changer to be checked.

MOUNTING & ERECTION:

The transformer shall be lifted by lugs or shackles or any other suitable means (such as dragging on rollers) and mounted on the concrete plinth prepared for the purpose. Care shall be taken to see that transformer is not titled during lifting and erection of transformer. The rollers shall be checked to prevent movement of the transformer after being positioned on the plinth. Adequate & necessary clearance from walls, other equipments, etc. shall be provided as indicated on the drawing.

All accessories and parts such as conservator tank, buchholz relay, breather, explosion vent, thermometer, etc. shall be mounted on the transformer. All bolts shall be tightened & all leakage’s shall be checked.

Oil level shall be checked & topped up, if necessary, with new oil. Di-electric strength of oil shall be tested as per IS specifications.

Insulation resistance of winding shall be measured with a 1000 volts magger & results shall tally with relevant IS specifications.

If di-electric strength of oil is found to be lower than the required level as per ISS, the oil shall be dried by filtration through a streamline filter plant.

Phasing out test with 415 volts applied to HV windings & voltage across LV windings shall be checked.

Measurement of neutral & body earth resistance shall be checked & the value shall not exceed 0.5 ohm.

Functioning of buchholz relay, thermometer, oil level indicator, Max. Temperature alarm & trip shall be checked & adjusted, if required. The transformer shall not be charged unless all above tests are successful & approval of local electrical inspectorate.
HIGH TENSION CABLE (XLPE) 11KV / 22KV / 33KV

1. **GENERAL**
The high tension cable shall be aluminium conductor, cross linked, polyethylene insulated, steel armoured construction. The conductors shall be made from electrical purity aluminium wire conforming to IS : 8130. The conductor shall be circular or sector shaped standard conductors. The cables shall conform to IS : 7098 Part II with latest amendments.

2. **RATING**
The cable shall be rated for a voltage for 11KV/ 22KV/ 33KV (As indicated in BOQ)

3. **CONSTRUCTION**
Insulation shall be of high quality unfilled insulating compound of natural colour. Insulation shall be applied by extrusion process and shall be chemically cross-linked in continuous vulcanisation process.

The cable shall be provided with conductor shielding and insulation shielding comprising of extruded semi-conducting compound. In addition, insulation shield shall be provided with semi-conducting and metallic-tape shield over the extruded insulation shield.

Inner conductor shielding, XLPE insulation and outer shielding shall all be extruded in one operation by a special extrusion process to ensure prefect bonding of inner and outer shielding with insulation.

Multi-core cable, cores shall be stranded together with suitable non-hygrosopic filler in the interstices and provided with common covering of plastic tape wrapping, or wrapped inner sheath, extruded inner sheath could be provided.

The cable shall be provided steel armouring and tough outer PVC sheath (IS : 5831)

4. **CORE IDENTIFICATION**
Cores shall be identified by numbers 1, 2 & 3 printed on the insulation.

5. **CURRENT RATING**
The current rating shall be based on the following conditions:-

```
a. Max. conductor temperature :  90°C  
b. Ambient air temperature    :  40°C  
c. Ground temperature         :  30°C  
d. Depth of laying            :  90 cm for cables upto 11 KV,  
                               105cm for 22 KV & 33 KV  
e. Thermal resistivity of soil :  105°C cm/ Watt.
```
6. SHORT CIRCUIT RATINGS

Short circuit ratings for the cables shall be based as per IS: 7098. However the rating shall be based on the following:

a. Max permissible conductor temperature under full load conditions : 90°C

b. Max. permissible short circuit temperature : 250°C

7. SELECTION OF CABLES:

The cables have been selected considering the followings:

a. Max connected load.
b. Ambient temperature.
c. Grouping of cables.
d. Short circuit level.

The contractor shall recheck the sizes before the cables are ordered, installed and connected to the services.

8. STORING, LAYING AND JOINTING

H.T cables shall be laid in trenches or ducts unless otherwise specified. Generally, laying, jointing and commissioning shall be as per the regulations of local authorities.

a) STORING:

On receipt of H.T cables at site, cable shall be inspected to detect any damage. The ends of cables shall be in sealed condition. After inspection, cables shall be stored in a proper place with battens of cables drums being replaced. The cable drums shall not be stored "ON FLAT" with flanges horizontal.

b) CABLES IN OUTDOOR TRENCHES IN GROUND

i. H.T cables shall be laid in outdoor trenches, if specifically called for, wherever cables are laid in outdoor trenches; the depth of the trenches shall not be less than 900mm plus radius of cable, from the upper surface of the ground. Where more than one multicore cable is laid in the same trench, a horizontal internal spacing of 30cm mm shall be left in order to reduce mutual heating & also be ensuring that fault occurring on one cable will not damage the adjacent cable. The trenches shall be cut square with vertical side walls and with uniform depth. Suitable shoring and propping may be done to avoid caving in of trench walls. The floor of the trench shall be rammed, levelled & shall be covered with 10cm thick layer of sand.

ii. The cables shall be laid in trenches over the rollers placed inside the trench (shall be removed after lying of cable & before filling of send). The cable drum shall be rolled in the direction of the arrow for rolling. Wherever cables are bent, the minimum bending radius shall not be less than 12 times the diameter of the cable. The cable shall be covered with a sand of 100mm thick layer. Over this sand layer, a layer of cable protection tiles / burnt bricks to overlap cables by 50mm on either side shall be provided. Trenches shall be back-filled with earth and
consolidated. Suitable cable markers made on concrete or cast iron indicating the voltage grade & direction of run of the cables shall be installed at regulator intervals.

c) CABLES IN INDOOR TRENCHES:

Cables shall be laid in indoor trenches where specified. The trenches shall be made of brick masonry with smooth cement mortar finish. The dimensions of the trenches shall be determined depending upon the maximum number of cables that is expected to be accommodated. Suitable clamps, hooks and saddles shall be used for securing the cables in position. Spacing between the cables shall not be less than 300mm centre to centre. Wherever specified, trenches shall be filled with fine sand and covered with RCC precast slabs or steel chequered covers. Unless otherwise called for specifically in SOQ, the making of indoor trenches is outside the scope of this work.

d) CABLES IN HUME PIPE IN GROUND:

Cable shall be laid in Hume pipe at a depth of not less than 1000mm from Ground level. Suitable size of Masonry man holes shall be used at an interval of 25 meters. The making of masonry man holes is outside the scope of this work.

9. CABLE JOINTING (STRAIGHT THROUGH):

Cable jointing shall be made as per the instruction of the cable manufacturer. Cable jointing shall be carried out only by qualified and competent cable jointers. A copy of manufacturer’s recommendations shall be submitted to the Consultants for approval and jointing shall not be done without prior approval of the Consultant. Straight through cable joint shall be carried out by using crimped type ferrule to the conductors. The ferrule shall then be taped with self amalgamating tape covering the cores upto the armour. A suitable stress core shall be provided. The joint shall be encapsulated in a special cast-resin compound and cable joint box. Armour bonding conductor and heavy duty clamp shall also be fitted before the cable is encapsulated in cast resin compound.

10. END TERMINATION:

XLPE cables shall be terminated into H.T. switchgear by using cable jointing kit.

a. Raychem  
b. 3M

11. TESTING

a. Insulation resistance of both sections of the cables to be jointed should be checked by a 1000V megger.  
b. H.T cable shall be pressure tested with stand a test voltage, as given below, for 15 minutes.

i. 11KV cable  
ii. 22KV cable  
iii. 33 KV cable

15 KV  
25 KV  
35 KV

However, local regulations with regard to test voltage and duration of application shall take precedence over the above
L. T. PANELS (POWER CONTROL CENTERS & SWITCH BOARD PANELS)

1.1 GENERAL:

Medium voltage power control centres (generally termed as switch board panels) shall be in sheet steel clad cubicle pattern, free floor standing type, totally enclosed, compartmentalized design. This specification shall cover the following types of panels:

a) Air circuit breaker panels - Drawout type with single or double tier arrangement as per design shown on the drawings.

b) Panels with one or more Air circuit breakers with Draw-out arrangement and switch-fuse units of non-drawout design.

c) Panels with switch-fuses of non-drawout type. However, the switch-fuse units can have drawout fuse-carriage if a particular make of switch-fuse is used.

d) The panels shall generally be of extensible type with provision for bus extension on or both sides as desired at the time of approved of shop drawings.

1.2 CODE/STANDARDS:

The panels shall generally conform to the requirements of following codes/ specifications:

a) IS-8623  
b) IS-4237  
c) IS-2147  
d) IS-3072  
e) IS-375  
f) IS-1248 & 2419  
g) IS-5082  
h) IS-2705  
i) IS-722  
j) IS-4064  
k) IS-2208  
l) IS-6875  
m) IS-6005

The equipment shall conform to Indian Electricity Rules as amended upto-date.

The supplier shall examine the provision of these codes and confirm or indicate his comments.

1.3 CONSTRUCTION:

Power control centres/ switch board panels shall of free standing type, with sheet steel enclosure having following features:

a) The panel shall be constructed of sheet steel of minimum 2.0 mm thickness. The internal frames shall be made of structural steel angles or made up sections (as per standard design of the manufacturer) specifications of which shall be submitted along with offers.

b) The panel shall be compartmentalised to accommodate one feeder in each compartment. The main bus bar chamber shall be provided at the top of panel or bottom of the panel as required. The compartments shall be arranged in section with metallic/ phenolic barrier in between.
A vertical cable alley of at least 200mm width shall be provided to serve one/two vertical section of feeders. Cable alley shall have hinged door/doors with rubber gaskets. Suitable cable clamping arrangement with slotted steel members shall be provided in the cable alley. Similarly, vertical bus bar shall be housed in-between two feeder compartments in a separate bus chambers. The opening between bus chamber and feeder compartments shall be properly covered with Bakelite/Hylam sheets of 3mm minimum thickness. The vertical bus chamber shall be provided with removable bolted covers on the front and back side. All the interconnecting links to the feeders shall be shrouded so as to avoid accidental contact, by means of phenolic barriers.

c) Each compartment shall have its own hinged door with concealed hinges. The doors shall have heavy duty rubber gasket fixed on the inner side of the door. The door shall have interlocking facility with the feeder unit.

d) The Panel shall have punched openings for mounting meters, lamps, push buttons, relays, etc.

e) The dimensions of feeder compartments, bus chambers and cable alleys shall be as shown on the relevant drawings. However, the following minimum dimensions shall be strictly adhered to:

i. ACB compartment : Drawout - 600mm wide x 1000mm deep x 900mm high.

ii. SWITCH FUSE UNITS/MOULDED CASE CIRCUIT BRACKER (NON-DRAWOUT TYPE):
   Up to 63A/100A : 300mm wide x 225mm high x 400mm deep
   250A : 400mm wide x 400mm high x 400mm deep
   400A to 630A : 400mm wide x 500mm high x 400mm wide.
   (Or vice-versa).

iii. BUS CHAMBER:
   Main bus (Horizontal) : 400mm high x 300mm deep
   Vertical bus (Feeder bus) : 300mm wide x 400mm deep

iv. Cable alley : Min. 200mm wide.

These dimensions are furnished as a guide and the clearances required in between each live bus/link and between bus/links to the earth (panel wall/sheet) shall be as per relevant Indian Standard Code of practice. However, minimum clearance between neutral bus and earth shall not be less than 25mm. The panel supplier shall furnish detailed sectional drawings and also arrange to get the panel inspection done at intermediate stages of fabrication to avoid fault defective fabrication of the panels (however, the compliance of these specifications shall entirely be the supplier's responsibility).
BUS BARS:

a) The bus bars shall be suitable for 3 phase, 4 wire, 415 volts 50 Hz AC supply. The bus bars shall be made of high conductivity aluminium. The bus bars shall have uniform cross-section throughout the length. The bus bars shall be designed for carrying rated current continuously. The bus bars and links shall be designed for a maximum temperature of 75°C. The max. current density of bus bars shall be as follows:

   i. Copper : 1.2 Ampere/ Sq.mm. of cross section area.
   ii. Aluminium : 1.0 Ampere/ Sq.mm. of cross section area.

It may be noted that these ratings are the upper limit to which the bus could be stressed. Suitable derating factors shall be applied to arrive at the correct cross section of bus bars.

b) Bus bars shall be supported on suitable non hygroscopic, non combustible, material such as DMC/ SMC at sufficiently close intervals to prevent bus bar sag. All bus bar joints shall be provided with high tensile steel bolts (electro plated with suitable metal such as Nickel/ Cadmium), spring washer and nuts so as to ensure good contact. Alternatively, electroplated/ tinned brass bolts shall be used. The joints shall be formed with fishplates on either side of bus bar to provide adequate contact area. Bus supports shall be provided on either side of joints (max. unsupported distance from the joint 400mm)

c) Power shall be distributed to feeders in dual section by a set of vertical bus bars (Phases+neutral). Individual module shall be connected to the vertical bus bars through sleeved connections.

d) Bus bars shall be insulated with PVC sleeves (heat shrink type) with colour coding (Red/ Blue/ Yellow/ Black).

e) The bus bars and their supports shall be able to withstand thermal and dynamic stresses due to the system short-circuits. The supplier shall furnish calculations along with his drawing establishing the adequacy of bus bars both for continuous duty and short circuit rating. Short circuit withstand capacity shall be for one second. Calculations for spacing of supporting of supports shall also be furnished.

1.5 EARTHING:

The panels shall be provided with a copper earth bus running throughout the width of the switchboard. Suitable earthing eye/bolts shall be provided on the main earthing bus to connect the same to the earth grid at the site. Sufficient number of star washers shall be provided at the joints to achieve earth continuity between the panels and the sheet metal parts.

1.6 MOUNTINGS:

Panels incorporating switch fuse units shall have suitable compartments of standard width. Each compartment shall incorporate a heavy duty load break switch fuse and HRC fuses. Suitable cable termination arrangement shall be provided for switch fuse/ fuse-switch unit feeders. Equipment shall be provided with proper fastening arrangements to ensure vibration free operation. Proper designation as given on the respective drawings shall be provided for every equipment.
Circuit breakers shall be mounted such that they are accessible from the front of the panel. More than two circuit breakers shall not be incorporated in a vertical section. The breakers compartment shall be divided into two parts, one for the breaker and the other for incorporating associated control gear. The necessary instrumentation shall be provided on the door of the compartment.

1.7 INTERLOCKING

The panels shall be provided with the following interlocking arrangements:

a. The door of the feeder compartments is so interlocked with the switch drive or handle that the door can be opened only if the switch is in “OFF” position. De-interlocking arrangement shall also be provided for inspection.

b. It shall not be possible for the breakers to be withdrawn when in “ON” position.

c. It shall not be possible for the breakers to be switched “ON” unless it is either in fully inserted position or for testing purposes in fully isolated position.

d. The breaker shall be capable of being racked into “testing”, “isolated” and maintenance position and kept in any of these positions.

e. A safety catch shall be provided to ensure that the movement of the breaker as it is withdrawn, is checked before it is completely out of the cubicle.

1.8 PROTECTION AND INSTRUMENTATION:

Protection and instrumentation shall be as per standard specification.

1.9 WIRING

All the interconnections between the incoming, bus and the outgoings of 100A and above rating shall be done by insulated links/ strips of suitable sizes. Switch fuses and equipments below 100A rating shall be wired with PVC insulated copper conductors. The wiring for instrumentation protection and control equipment shall be carried out with PVC insulated flexible copper conductors.

The Power interconnections shall be carried out by means of bolted connections with washers. The wiring shall be terminated by using crimping sockets. Wring shall be laid out neatly in bunches which are fastened to the steel members of the panel. All the potential circuits shall be protected by fuses mounted near the tap-off point from the main connections.

1.10 TERMINALS:

All the control, instrumentation and protection wiring shall be provided with printed PVC ferrules at both ends. For terminating control cables on to the equipment in the panels, suitable terminals blocks shall be provided. The terminal shall also be numbered for easy identification and maintenance.

1.11 SURFACE TREATMENT

All sheet metal accessories and components of power, control centres and switchboard panels shall be thoroughly cleaned, degreased, derusted and phosphatised before
red oxide primer is applied. The panel shall be stove enamelled to the required final finish. The interior surfaces of the panel shall also be painted to required shade. The supplier shall indicate in his offer, if there is any deviation from the treatment specified above.

1.12 ENCLOSURES

The panel enclosure shall be dust and vermin proof and shall be suitable for indoor installation. Enclosure design shall be in accordance with the requirements of IP 54 as per IS-2147-1962. The supplier shall confirm whether this requirement is met and a type test certificate furnished. If type test certificate for IP-54 is not available, the same shall be brought out clearly in his offer.

1.13 NAME PLATE

The panel as well as the feeders compartment doors shall be provided with name plates giving the switchboard/feeder descriptions as indicated on the drawings.

1.14 TESTING

The power control centres shall be tested at factory after assembling of all components and completion of all interconnections and wiring. Tests shall be conducted in accordance with the requirements relevant IS Codes/specifications.

a. INSULATION TEST
i. Insulation of the main circuit, that is, the insulation resistance of each pole to the earth and between the poles shall be measured.
ii. Insulation resistance to earth of all secondary wiring should be tested with 1000V megger. Insulation test shall be carried out both before and after high voltage test.
iii. Surface finish and paint thickness test along with bus bar tightening & clearing test.
v. Dimensional, appearance & sheet thickness test.
b. HIGH VOLTAGE TEST:
A high voltage test with 2.5KV one minute shall be applied between the poles and earth. Test shall be carried out on each pole in turn with the remaining poles earthed. All units racked in position and the breakers closed. Original test certificate shall be submitted along with panel.

1.15 STORING, ERECTION AND COMMISSIONING

a. STORING
The panels shall be stored in well ventilated, dry places. Suitable polythene covers shall be provided for necessary protection against moisture.

b. ERECTION
Switchboards shall be installed on suitable foundation. Foundation shall be as per the dimensions supplied by the panel manufacturer. The foundation shall be flat and levelled. Suitable grouting holes shall be provided in the foundation. The switch boards shall be properly aligned and bolted to the foundation by at least four bolts. Cable shall terminate on the bottom plate or top plate as the case may be, by using brass compression glands.
The individual cables shall then be lead through the panel to the required feeder compartments for necessary terminations. The cables shall be clamped to the supporting arrangement. The switch board earth bus shall be connected to the local earth grid.

c. **PRECOMMISSIONING TESTS:**
Panels shall be commissioned only after the successful completion of the following tests. The tests shall be carried in the presence of engineer-in-charge.

i. All main and auxiliary bus bar connections shall be checked and tightened.

ii. All wiring terminations and bus bar joints shall be checked and tightened.

iii. Wiring shall be checked to ensure that it is according to the drawing.

iv. All wiring shall be tested for insulation resistance by a 1000V megger.

v. Phase sequence/rotation shall be estimated.

vi. Suitable injection tests shall be applied to all the measuring instruments to establish the correctness and accuracy of calibration and working order.

vii. All relays and protective devices shall be tested for correctness of settings and operation by introducing a current generator and an ammeter in the circuit.


xi. Tightness of fish plates.
AIR CIRCUIT BREAKERS

1.0 GENERAL

1.1 Air Circuit breakers shall be air break, metal clad horizontal draw out type fully interlocked and meeting the requirements of Indian Standards. Breakers shall be rated for a medium voltage of 690V and rated full load amperes as indicated on drawings. Breaker shall be capable of making and breaking system short circuits as specified.

1.2 Breakers shall be manually operated with remote operation facility, complete with front-of-the-panel operating handle, isolating plug with safety shutters, mechanical ON/OFF indicator, silver plated arching and main contacts, arc chutes suitably designed to provide larger arc elongation, trip free operation. Breakers shall be capable of being racked out into 'Testing', 'Isolated', 'Service' and 'Maintenance' position and kept locked in any position. Breakers for remote operation shall be motor operated spring charged. Each pole shall have complete isolation from the other.

2.0 Technical parameters

The Circuit Breaker shall be of air break type of robust and compact design, suitable for indoor mounting and conforming to IS / IEC 60947 part 1 & 2 with symmetrical rupturing capacity at 415 Volts as per BOQ and drawings. All circuit breakers shall be provided with over current/ short circuit and earth fault releases.

The ACB should be designed at an ambient temperature (free air temperature) of 50 Deg C. However there should be no de rating of ACB at inside panel temperature of 50 deg C.

The Rated insulation voltage shall be 1000 volts AC & Rated impulse withstand Voltage shall be 12kV for main circuit.

Rated Service short Circuit Breaking capacity (Ics) shall be 50KA/65KA or as per BOQ and should be equal to the Rated ultimate Short circuit breaking capacity (Icu) and short circuit withstand values (Icw) for 1 sec.

All 4 Pole ACBs should have 100% neutral rating.

3.0 Constructional features

3.1 Each Circuit Breaker shall be housed in a separate compartment enclosed on all sides. The Circuit Breaker cradle shall be designed and constructed to permit smooth withdrawal and insertion. The movement shall be free of jerks, easy to operate and positive.

3.2 Air Circuit Breakers shall be provided in fully draw out cubicles. These cubicles shall be such that draw out is possible without disconnection of the wires and cables. The power and control circuits shall have self-aligning and self-isolating contacts. The fixed and...
moving contacts shall be easily accessible for operation and maintenance. Mechanical interlocks shall be provided on the draw out cubicles to ensure safety and compliance to relevant Standards.

3.3 Self-aligning cluster type isolating contacts shall be provided for the Circuit Breaker, with automatically operated shutters to screen live cluster contacts when the Breaker is withdrawn from the cubicle. Sliding connections including those for the auxiliary contacts and control wiring shall also be of the self aligning type. The fixed portion of the sliding connections shall have easy access for maintenance purposes.

3.4 The automatic shutters shall be earthed and connected to the earth bus.

3.5 A slow closing facility should be available to close the contacts slowly for contact alignment & adjustment as a maintenance feature.

3.6 Electrical life of breaker without maintenance should be 10000 operations up to 2000A and 5000 operations for 2500A -5000A breaker.

3.7 ACB to be provided with adaptor terminals for better termination.

4.0 Operating mechanism

4.1 The Circuit Breaker shall be trip free with independent manual dual co-axial spring operated and/or motor wound dual co-axial spring operated mechanism as specified with mechanical ON/OFF indication. The operating mechanism of the circuit breaker is free at all time to open immediately when the trip coil is energized. The operating handle and mechanical trip push button shall be at the front of and integral with the Circuit Breaker.

4.2 The Circuit Breaker shall have the following three distinct and separate positions, which shall be indicated on the face of the panel.

"Service" -- Both main and secondary isolating contacts closed

"Test" -- Main isolating contacts open and secondary isolating contacts closed

"Isolated" -- Both main and secondary isolating contacts open

5.0 Circuit breaker interlocking

5.1 Sequence type strain free interlocks shall be provided to ensure the following:

a) It shall not be possible for the Breaker to be withdrawn from the cubicle when in the "ON" position. To achieve this, suitable mechanism shall be provided to lock the Breaker in the tripped position before the Breaker is isolated.

b) It shall not be possible for the Breaker to be switched "ON" until it is either in the fully inserted position or, for testing purposes, it is in the fully isolated position.
c) It shall not be possible for the Circuit Breaker to be plugged in unless it is in the OFF position.

d) A safety catch shall be provided to ensure that the movement of the Breaker, as it is withdrawn, is checked before it is completely out of the cubicle, thus preventing its accidental fall due to its weight.

6.0 Anti pumping

Mechanical and electrical anti-pumping devices shall be incorporated in the Electrically operated circuit breakers.

7.0 Circuit breaker auxiliary contacts

The Circuit Breaker shall have minimum 4 N.O. and 4 N.C. auxiliary contacts rated at 16 A 415 volts 50 Hz. These contacts shall be approachable from the front. They shall close before the main contacts when the Circuit Breaker is plugged in and vice versa when the Circuit Breaker is Drawn Out of the cubicle.

8.0 Protective Devices

All ACBs except bus couplers should be equipped with micro-controller based 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 with adjustable time delay.
- Short time protection with intentional delay.
- Instantaneous protection.
- Ground fault protection.

ACB releases shall have LED/LCD display of Phase & Neutral currents

In addition to above the Release of **Incomer Level ACBs (Transformer & DG Set)** shall have display and protection of all Energy & Power parameters, and last 5 fault / trip history and provide actual %age loading at any instant, Temperature monitoring & Tripping of breaker, Communication on MODBUS RTU protocol using RS485 port and additional Protections (as per SOQ) like –Under & Over Voltage, Under & Over Frequency, Directional S/C protection, Harmonics measurement, Phase Sequence, Maximum Demand, Leading & Lagging Power Factor etc.

8.0 Type test certificates

The Contractor / venders shall submit type test certificates for Combined test sequence as per Standards from a recognized test house for each type of Circuit Breakers offered.
1.1 **GENERAL:**
Moulded case circuit breakers or fuse free breaker shall be incorporated in the switchboard wherever specified. MCCBs should be current limiting type with trip time of less than 10 msec under short circuit conditions. MCCBs shall conform to IS/IEC60947 part 1 & 2 in all respects. MCCBs shall be suitable either for single phase 230V or three phase 415 volts. The rated insulation voltage shall be 800V and impulse withstand voltage should be 8Kv.

1.2 **CONSTRUCTION:**
The MCCB and case shall be made of high strength heat resistant and flame retardant thermo-setting insulating material. Operating handle shall be quick make/quick break, trip-free type. The operating handle shall have suitable “ON”, “OFF” and “TRIPPED” indicators. Three phase MCCBS shall have a common operating handle for simultaneous operation and tripping of all the three phase. Suitable arc extinguishing device shall be provided for each contact. Contact tips shall be made of suitable arc resistant, sintered alloy for long electrical life. Terminals shall be of liberal design with adequate clearances.

1.3 **ACCESSORIES:**
MCCBs shall be provided with the following accessories, if specified in schedule of quantities:

i. Under voltage release

ii. Shunt release

iii. Trip alarm

iv. Auxiliary contacts.

*All MCCBs above 63A shall be provided with Silver Plated Copper Spreader Links for enhancing termination capacity*

1.4 **INTERLOCKING:**
Moulded case circuit breakers shall be provided with the following interlocking devices for interlocking the door of switch board:

a. Handle interlock to prevent unnecessary manipulation of the breaker.

b. Door interlock to prevent the door being opened when the breaker is in “ON” position.

c. De-interlocking device to open the door even, if the breaker is in “ON” position.

1.5 **BREAKING CAPACITY:**
The moulded case circuit breaker shall have a Rated Service Short Circuit breaking capacity \(I_{cs}\) of not less that 25kA rms at 415 VAC \(I_{cs} = I_{cu}\). Wherever required, higher breaking capacity breakers of Rating 35kA / 50kA / 65kA to meet the system short circuit fault shall be used. All such ratings shall be as per equipment schedule/S.O.Q.
1.6 Protective Release

All MCCBs above 100A shall have Variable Thermal (O/L) & Variable Magnetic (S/C) protection settings.

All MCCBs of 250A and above shall be of Microprocessor Based with adjustable Overload, Short Circuit and In-Built Earth Fault Protection.

In case 3 Pole MCCBs are specified for 3 Phase 4 Wire Systems, and the MCCB are with Micro processor base release with earth fault protection, the Vendor should provide external Neutral CT from MCCB Manufacturer.

For Motor application, motor duty type MCCBs shall be selected with reference to Type 2 coordination chart provided by the manufacturer.

1.6 TESTING:

a. Original certificate of the MCCBS as per latest standards specified shall be furnished.

b. Pre-commissioning tests on the switch boards panel incorporating the MCCB shall be done as per specifications.
METERING, INSTRUMENTATION AND PROTECTION

1.0 GENERAL

The Specifications hereinafter laid down shall cover all the meters, instrumentation and protective devices required for the electrical work. The ratings, type and quantity of meters, instruments and protective devices shall be as per the schedule of quantities and drawings.

2.0 INSTRUMENT TRANSFORMERS

a. Current Transformers:
Current transformers shall be in conformity with IS:2705 (Part I, II and III) in all respects. All current transformers used for medium voltage applications shall be rated for 1 KV. Current transformers shall have rated primary current, rated burden and class of accuracy as specified in the schedule. However, the rated secondary current shall be 5A unless otherwise specified. The acceptable minimum class of various applications shall be as given below.

<table>
<thead>
<tr>
<th>Application</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring</td>
<td>0.5 to 1</td>
</tr>
<tr>
<td>Protection</td>
<td>5P10</td>
</tr>
</tbody>
</table>

Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault of 35 MVA on medium voltage system. Terminals of the current transformers shall be paired permanently for easy identification of poles. Current transformers shall be provided with earthing terminals for earthing chassis frame work and fixed part of the metal casing (if any). Each C.T shall be provided with rating plate indicating the following:

i. Name and Make

ii. Serial Number

vi. Transformation ratio

iv. Rated burden

vii. Rated Voltage

viii. Accuracy class

Current transformers shall be mounted such that they are easily accessible for inspection, maintenance and replacement. The wiring for CTs shall be with copper conductor PVC insulated wires with proper termination lugs and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner.

b. Potential Transformers:

Potential Transformers shall be provided if specifically called for. Potential transformers shall comply with the requirements of IS: 3156 (Part I, II and III) in all respects.
3.0 **MEASURING INSTRUMENTS:**

a. **General**
   Electrical instruments shall be digital type and shall be in conformity with IEC – 62053-22. The accuracy of direct reading shall be 1/.5 for Voltmeters and 1/.5 for ammeters. Other type of instrument shall have accuracy of 1/.5. The errors due to variations in temperature shall be limited to a minimum. The meters shall be suitable for continuous operation between 0°C and 55°C. All meters shall be of flush mounting type with 96x96 sq. mm. The meter shall be enclosed in a dust tight housing. The housing shall be of ABS Body. The design and manufacture of the meters shall ensure the preventing of fogging of instrument glass. Instrument meters shall be sealed in such a way that access to the measuring element and to the accessories within the case shall not be possible. Meters shall be provided with 12.5 mm height LED display. Suitable selector switches shall be provided for all ammeters and voltmeters intended to be used on three phase supply.

b. **Ammeters:**
   Ammeters shall be of digital LED display type. The ammeters shall be manufactured and calibrated as per the latest edition of IEC 62053-22. Ammeters shall be instrument transformer operated and shall be suitable for 5A/1A secondary of instrument transformer. The ammeter shall have sensitivity of 5% minimum.

   The scale shall be calibrated to indicate primary current, unless otherwise, specified. The ammeter shall be capable of carrying substantial overloads upto 120% of ratio current during fault condition without damage or loss of accuracy.

c. **Voltmeters :**
   Voltmeters shall be of digital LED display type as per IEC 62053-22. The range of 400 Volts, 3 Phase Voltmeter shall be 0 to 500 Volts. inbuilt selector switch shall be provided for each voltmeter to read voltage between any two lines of the system. The voltmeter shall be provided with protection fuse of suitable capacity.

d. **Wattmeter, Frequency Meters, Power Factor Meters:***
   i. Watt meters shall be of three phase, electronic type suitable for use with current & potential transformers associated with the particular panel. As per IS: 13779 Accuracy class 1/.5 IEC 62053-22/CB 1P-88.

   ii. **Power Factor Meters:**

   Poly phase power factor meters shall be of digital type with current and potential coils suitable for operation with current transformers and potential transformers associated with the particular panel. The scale shall be calibrated for 50% lag-100%-50% lead readings. Phase angle accuracy shall be + 2 degrees/1 degrees.

   iii. **Energy meters and reactive power meters:**

   Trivector meters shall be two elements, integrating type kilowatt hour, KVA kilovolt-ampere-hour reactive meters. The meters shall conform to IEC 62053-22/CB 1P-88 in all respects. Energy meters, KVAH and KVARH meters shall be provided with integrating registers. The registers shall be able to record energy consumption of 500 hours corresponding to maximum current at the rated
voltage and unity power factor. These meters shall be suitable for operation with current and potential transformers associated with the particular panel and can also be integrated with PC with RS 485 port for energy management system.

4.0 RELAYS:

a. General

Protection relays shall be provided wherever required to trip and isolate the particular section under fault. All the relays shall be provided with flag type indicators to indicate the cause of tripping. The flag indicators shall remain in position until they are reset by hand reset.

Relay shall be designed to make or break the normal circuit current with which they are associated. The relay contacts shall be of silver or platinum alloy. The contacts shall be designed to withstand repeated operation without damage. The relays shall be of draw-out to facilitate testing maintenance. Draw-out case shall be dust tight with a finish suitable for tropical country. The relays shall be capable of disconnecting the faulty section of the network or fault equipment without causing interruption or disturbance to the remaining sections. The analysis of setting shall be made considering relay errors, pick-up and overshoot errors and shall be submitted to the Owners Engineer/Architect/Consultant for approval.

b. Over current Relay:

Over current relay shall be induction type with inverse definite minimum time lag characteristics. The over circuit relays shall be provided with adjustable current and time settings. The setting for current shall be 50 to 200% in step of 25%. The IDMT over current relays shall have time lag (delay) of 0 to 3 seconds. The time setting multiplier shall be adjustable from 0.1 to unity. Over current relays shall be fitted with suitable tripping device with trip coil being suitable for operation on 5Amp.

c. Earth Fault Relay:

Earth fault relay shall have current setting of 10% to 40% in steps of 10% otherwise, the earth fault relay shall conform to specification laid down for over current relays.

d. Under Voltage Relays:

Under Voltage Relays shall be induction type and shall have inverse limit operation characteristics, with pickup voltage range of 50-90% of the rated voltage.

5.0 TESTING

5.1 Instrument transformers shall be tested at factory as per IS: 2705 and IS: 3156. The test shall incorporate the following:

Routing Tests:

Original test certificates in triplicate shall be provided.
5.2 Meters shall be tested as per IS: 1248. The tests shall include routine tests. Original test certificate in triplicate shall be furnished.

5.3 Suitable injection tests shall be applied to the secondary.

   a. Circuit of every instrument to establish the correctness of calibration and working order all relays and protective devices shall be tested to establish the correctness of setting and operation by introducing a current generator and an ammeter in the circuit.

POWER FACTOR IMPROVEMENT SYSTEM:

1.1 GENERAL:

The Power factor improvement system shall comprise of capacitors and associated switchgear and control gear as per the requirements so as to achieve power factor of 0.995.

1.2 CAPACITORS:

Power factor correction capacitors shall be MPP-Heavy duty / Gas filled (as per BOQ) conform in all respects to IS 13340-1993, IS 13341-1992, IEC 60831-1 & 2. Capacitors shall have approval of fire insurance association of India. The capacitors shall be suitable for 3 Ø 415 V, at 50 Hz frequency & shall be available in three phase units of 5, 10, 15, 20, 25 and 50 KVAR sizes. The capacitors shall be suitable for indoor use up to ambient temperature of 50°C. The permissible overloads shall be as given below:-

   a. Voltage overload shall be 10% for continuous operation and 15% for 30 min in a 24 hour cycle.

   b. Current overload shall be 15% for continuous operation and 50% for 6 hours in a 24 hour cycle.

   c. Overload of 30% continuously and 45% for 6 hours in a 24 hour cycle. Capacitors shall be hermetically sealed in sturdy corrosion proof, sheet steel containers and impregnated with non-inflammable synthetic liquid. The capacitors shall have suitable discharge device to reduce the residual voltage from crest value of the rated voltage to 50 V or less within one minute after capacitor is disconnected from the source of supply. The Power losses of capacitor shall not exceed 0.5W/Kvar. The capacitors shall withstand voltage of 2500 V ac (power frequency test voltage) for one minute. The insulation resistance between capacitors, terminals and containers when test voltage of 500V DC is applied shall not be less than 50 mega ohms.

1.3 DETUNED REACTORS:

Suitable Copper wound detuned (7% or 14% as per BOQ) reactors shall be provided to mitigate harmonics in electrical network. The reactors shall be copper wound with high degree of linearity. The reactor shall be provided with thermal cut off facility.
When used in series with 7% / 14% detuned reactor, the capacitors shall be rated for 480 / 525V respectively. The KVAR shall be selected accordingly.

1.4 **APFC RELAY:**

Micro controller based relay / controller having required number of steps shall be provided. The relay shall measure KVAR and display instantaneous value of power factor, alarms for under / over compensation, capacitor over load etc.

1.5 **CAPACITOR CONTROL PANEL:**

The capacitor control panel shall generally comprise of following:

a) Power factor correction relay
b) Step controller with reversing motor.
c) Time delay and no-volt relays.
d) Contactor & fuses/ MCCBs/ MCBs for individual capacitor banks.
e) Auto- manual selector switch for either manual or automatic operation.
f) Current Transformers (On main LT Panel)
g) ON/OFF indicating lamps with fuses for each bank
h) ON/OFF Push Buttons for each bank.

1.6 **CONTROL PANEL:**

The capacitor control panel shall be fabricated out of 2.0 mm thick for load bearing members and 1.6 mm thick non load bearing member, sheet steel suitably rust inhibited and stove enamelled. The panel shall have adequate space for mounting the capacitors. The panel shall be of dust and vermin proof construction with suitable ventilation arrangement for capacitors. Panels shall be dead front pattern and floor mounting type, complete with cabling arrangement, bus bars and earthing, etc.

**SWITCH GEAR & PROTECTION**

Incomer switchgear shall be TP&N breaker appropriate rating. Suitable capacitor duty contactor for each step shall be used and must be capable of capacitor switching duty at each step for short circuit protection. Busbars shall be suitably colour coded and must be mounted on appropriate insulator supports.

All capacitors shall be suitably protected against over current and short circuit by suitably rated HRC Fuses/ MCCB as mentioned in SOQ.

Power cables used shall have superior mechanical, electrical and thermal properties, and shall have the capability to continuously operate at very high temperatures upto 125 deg.C.

Internal wiring between main bus-bars, breaker, contactor and capacitors shall be made with 1100 V grade, FRLS PVC insulated, copper conductor cable of appropriate size, by using suitable copper crimping terminal ends etc. Suitable bus links for input supply cable termination shall be provided.
GENERAL SPECIFICATION FOR: MEDIUM VOLTAGE CABLES

1.1 TYPE:
Medium voltage cables shall be aluminium conductor, PVC insulated, PVC sheathed or XLPE and steel wire armoured or steel tape armoured construction. Aluminium conductors up to 10sq.mm may be solid, circular in cross section, and sizes above 10sq.mm shall be stranded. Sector shaped stranded conductors shall be used for sizes above 25sq.mm. The cable shall conform to IS 1554 (Part I) for PVC & IS 7098 (Part-I) for XLPE Cables.

1.2 RATING
The cable shall be rated for a voltage of 650/1100 Volts.

1.3 CONSTRUCTION
The conductors for power cables shall be made of high conductivity aluminium & Copper / control cable from annealed high conductivity copper (complying with IS 8130 - 1984). The conductors shall be insulated with high quality PVC base compound. A command covering (bedding) shall be applied over the laid up cores by extrusion or wrapping of a filling material containing unvulcanized rubber or thermoplastic material, armouring shall be applied over the inner sheath of bedding, over the armouring a tough outer sheath of PVC sheathing shall be extruded. The outer sheath shall bear the manufacturers name and trade mark at every 30 meter interval.

1.4 CORE IDENTIFICATION:
Core shall be provided with the following colour scheme of PVC insulation.

i. 1 Core : Red / Yellow / Blue
   ii. 2 Core : Red and Black
   iii. 3 Core : Red, Yellow, and Blue
   iv. 3.5/4 core : Red, Yellow, Blue and black.

1.5 CURRENT RATINGS:
The current rating shall be based on the following conditions.

<table>
<thead>
<tr>
<th></th>
<th>PVC</th>
<th>XLPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. Maximum conductor temperature</td>
<td>70°C</td>
<td>90°C</td>
</tr>
<tr>
<td>ii. Ambient air temperature</td>
<td>40°C/50°C</td>
<td>40°C/50°C</td>
</tr>
<tr>
<td>iii. Ground temperature</td>
<td>35°C/40°C</td>
<td>35°C/40°C</td>
</tr>
</tbody>
</table>
iv. Depth of laying: 75cm

1.6 SHORT CIRCUIT RATING:

Short circuit ratings for the cables shall be as specified in IS: 1554 Part -I. for PVC & IS 7098 (Part-I) for XLPE Cables.

1.6 VOLTAGE DROP:

Voltage drop for the feeders shall not exceed 2% at the design load, Voltage drop for the branch circuit shall not exceed 3% at design load.

1.7 SELECTION OF CABLES:

Cables have been selected considering the conditions of the maximum connected load, ambient temperature, grouping of cables & the allowable voltage drop. However, the contractor shall recheck the sizes before the cables are fixed and connected to the service.

a. Storing

All the cables shall be supplied in drums. On receipt of cables at site, the cables shall be inspected and stored in drums with flanges of the cable drums in vertical position.

b. Laying

Cables shall be laid as per the specifications given below. The system adopted for this job shall be as per SOQ:

i. Duct system

Wherever specified cables shall be laid in underground ducts, the duct system shall consist of a required number of reinforced “HUME” pipes with simplex joints. Wherever asbestos cement pipes are used, the pipes shall be enclosed in concrete of 75mm thick; the ducts shall be properly anchored to prevent any movement. The top surface of the cable ducts shall be laid with a gradient of atleast 1:300. The ducts shall be provided with inspection manholes and all direction changes and at required regular intervals for drawing the cable. The manholes shall be of reinforced concrete either cast-in-situ or precast. The manhole cover and frame shall be of cast iron and machine finished to ensure a perfect joint. The manhole cover shall be installed flush with ground or paved surfaces. The duct entry to the manholes shall be made leak proof with lead-wool joints. The ducts shall be properly plugged at the ends to prevent entry of water rodents, etc. Suitable duct markers shall be placed along the run of the cable square embedded in concrete, indicating the voltages, no of ducts and the direction of run of the cable duct. Suitable cable supports made of angle iron shall be provided in the manholes for supporting the cables. Proper identification tags shall be provided for each cable in the manholes.
ii. **Cables in outdoor trenches:**

Cables shall be laid in outdoor trenches wherever called for. The depth of the trenches shall not less than 75cm from the final ground level. The width of the trench shall not be less than 45cm. However, where more than one cable is laid, an axial distance of not less than 15cm shall be allowed between the cables. The trenches shall be cut square with vertical side walls and with uniform depth. Suitable shoring and propping may be done to avoid caving in of trench walls. The floor of the trench shall be rammed, levelled & shall be covered with 8cm thick layer of sand. The cables shall be laid in trenches over the rollers placed inside the trench. The cable drum shall be rolled in the direction of the arrow for rolling. Wherever cables are bent, the minimum bending radius shall not be less than 12times the diameter of the cable. The cable shall be covered with 8 cm. thick sand cushion. Over this, a course of cable protection tiles or burnt brick shall be provided to cover the cables 50mm on either side. Trench shall be backfilled with earth and consolidated. Cables shall be laid in Hume pipes at all road crossings and in CI pipes at the wall entries. Approved cable markers made of aluminium or CI indicating the voltages, no. of cables and the direction of rep. Of the cables shall be installed at a regular interval of 30 meters.

iii. **Cables in indoor trenches:**

Cables shall be laid in indoor trenches where specified. The trenches shall be made of brick masonry with smooth cement mortar finish. The dimensions of the trenches shall be determined depending upon the maximum number of cables that is expected to be accommodated. Cables shall be arranged in tier formation inside the trenches. Suitable clamps hooks and saddles shall be used for securing the cables in position. Spacing between the cables shall not be less than 15cm centre to centre. Wherever specified, trenches shall be filled with fine sand and covered with RCC precast slabs or steel chequered covers. Unless otherwise called for specifically in SOQ, the making of indoor trenches is outside the scope of this work.

iv. **Cable on Tray/ Racks:**

Cables shall be laid on cable trays/ racks wherever specified. Cable racks/trays shall have ladder type or channel design suitable for the purposes. The nominal depth of the trays/ racks shall be 150mm. The width of the trays shall be as per the design shown on drawing. The cable trays shall be made of steel or aluminium. The trays/ racks shall be completed with end plates, tees, elbows, risers, and all necessary hardware. Steel trays/ Rack shall be painted with two coats of enamel paint of approved shade over a coat of red oxide primer. Cable trays shall be erected properly to present a neat and clean appearance. Suitable cleats or saddles made of aluminium strips with PVC covering shall be used for securing the cables to the cable trays. The cable trays shall comply with following requirements:
1. The trays shall have suitable strength and rigidity to provide adequate supports for all contained cables.

2. It shall not present sharp edged, burrs or projections injurious to the insulation of the wiring/cables.

3. If made of metal, it shall be adequately protected against corrosion or shall be made of corrosion resistant material.

4. It shall have side rails or equivalent structural members.

5. It shall include fittings or other suitable means for changes in direction and elevation of runs.

1.9 INSTALLATION

1. Cable trays shall be installed as a complete system. Trays shall be supported properly from the building structure. The entire cable tray system shall be rigid.

2. Each run of the cable tray shall be completed before the installation of cables.

3. In portion where additional protection is required, non combustible covers/enclosures shall be used.

4. Cable tray shall be exposed and accessible.
GENERAL SPECIFICATION FOR: MEDIUM VOLTAGE DISTRIBUTION BOARDS

1.1 General:

Distribution boards for Power & light circuit distribution shall be factory built and shall be suitable for 415volts, 3phase or 230 volts single phase supply as specified in BOQ. The voltage drop at the distribution level should not exceed 3% of the total power usage. The distribution boards shall conform to IS 8623 (for factory built assemblies).

1.2 Makes:

Makes of DB's shall be as per Acceptable Material / Approved List.

1.3 Type

The following boards shall be of cabinet design, totally enclosed and shall provide protection against ingress to IP 42 of IS 2147. Only those types of DBs which have been type tested and passed by a national laboratory for IP 42 shall be offered.

However, if none of the type available from the approved makes to meet the above requirements, alternative makes can be offered with technical literature and copy of test certificate.

1.4 Components:

Distribution boards shall generally be provided with the following major components:

a. Miniature circuit breeders
b. Earth leakage circuit breakers
c. Bus Bars
d. Neutral links/bus
e. Earth Bus

1.5 Miniature Circuit Breakers:

MCBs shall generally conform to IS 8828. The breaking capacity of MCBs shall not be less than 10kA the miniature circuit breakers shall suitable for snap fixing on a standard DIN rail. The MCBs shall be suitable for operating under full load under ambient temperature conditions (i.e. -10°C to 55°C in India. MCBs shall have terminals suitable for receiving aluminium cables of adequate cross section. (Upto 32A rating 16sq.mm. & 40, 50, 63A 35sq.mm cable). Three phase MCB's shall have common trip bar so that all the poles make and break simultaneously.

1.6 Earth Leakage Circuit Breakers:

Earth leakage circuit breakers shall be used as incomers in distribution boards wherever specially called for in SOQ, ELCB shall be suitable for incorporation in standard DB manufactured by the approved manufacturers. ELCBs shall be of core
balance type and shall not cause nuisance tripping. The ELCB shall be rated for 100mA fault circuit tripping. ELCB shall be provided with a test lamp and push button to test the healthiness of the circuit.

1.7 **Bus Bars:**

The bus bars shall be of copper and duly tinned or plated. The bus bar rating shall be at least 100A as per manufacturers design.

Single phase DBs shall have Bus bars solidly anchored with single pole MCBs of specified ratings. The bus bars shall be fully shrouded. The bus bars shall be able to accept single, double or triple pole MCBs.

Three phase DBs shall have single piece bus bar and coupling link avoiding drilling and bolting of bus bars.

However, if the above 'unique bus bars' system is not available from the approved manufacturers alternative makes can be offered with full technical particulars.

1.8 **Cabinet:**

The DB cabinet shall be made of at least 1.6 mm thick sheet steel duly stove enamelled or powder coated (as per standard manufacturing product). The cabinet shall be suitable for either recess mounting or surface mounting.

The cabinet shall be provided with conduit cable entry knock-outs at top and bottom or top and bottom plates shall be of detachable construction. The cabinet shall be dust and vermin proof with proper gaskets for the front door.

The DB cabinet and internal mounting arrangements shall be such that the entire bus and MCB assembly could be easily detachable from the cabinet.

1.9 **DIRECTORY**

Distribution boards shall be provided with a write and protect directory indicating the area of loads served by each circuit breakers, the rating of breakers, size of conductors, etc. The directory shall be mounted in front of cabinet with an acrylic door.

1.10 **INSTALLATION:**

Distribution boards shall be surface mounted or recessed mounted as required. DBs shall be mounted at the locations as shown on the approved execution drawings.

Surface boards shall be fixed with suitable angle iron clamps and bolts. All the cables/ conduits shall be properly terminated using glands/ check nuts etc. Wiring shall be terminated properly using crimping lugs/ sockets & PVC identification ferrules. Distribution boards shall be bonded to the earth at least on two points using brass bolts & lugs. Suitable name plate and danger plate, indicating the voltage shall be fixed to the front cover.

1.11 **TESTING:** Distribution boards shall be tested at factory as per IS 8623 and original test certificate shall be furnished.
GENERAL SPECIFICATION FOR: MEDIUM VOLTAGE DISTRIBUTION SYSTEM

(Internal lighting & Power Wiring)

1.1 GENERAL:

Medium voltage distribution system shall be applicable for wiring 3Phase, 4 wire 415 Volts, 50 HZ, AC supply and single phase, 2 wire 230 Volts, 50 HZ, AC supply.

1.2 REGULATION AND STANDARDS

The system shall be governed by the requirements of IS: 732 and I.E Rules and NEC. IS standards and Codes applicable for medium voltage distribution is also listed in specification.

1.3 REGID STEEL/PVC CONDUIT AND ACCESSORIES:

1.3.1 Rigid ERW steel/PVC conduit (as per SOQ) shall be screwed, sheet steel electric resistance welded and black stove enamelled (outside) and shall conform to IS 9537 Part I.

1.3.2 Makes of DB’s shall be as per Acceptable Material / Approved List.

1.3.3 In case, any of the above makes does not bear ISI certification mark the contractor shall furnish a list of makes, which bear ISI certification mark, to choose from.

1.3.4 The conduit shall be routine tested at the works as per IS specifications and original test certificate furnished along with each major consignment delivered. The engineer-in-charge will determine size of the consignments requiring the original test certificate.

1.3.5 In general, conduits shall be of good quality and shall form to the following requirements:

   a. Shall be free from welding burrs.
   
   b. Wall thickness shall be uniform as far as possible.
   
   c. Ends shall be screwed.

1.3.6 Conduit accessories such as bends, inspection tees, round junction boxes, elbows, draw boxes etc. shall be of good quality and shall generally in conformity with IS specifications. The fittings and accessories shall have threads or shall have internally tapped spouts. Junction boxes/inspection boxes shall have suitable covers with screws.

1.3.7 Installation of conduits:

   a. Open/Surface conduit system:

Wherever, specifically called for, surface conduit system shall be adopted. Conduits shall be run in square and symmetrical lines. Before the conduits are installed the exact route shall be marked at site and approval of the engineer shall be obtained. Conduits shall be
fixed by saddles, secured to suitable raw plugs, at an interval of not more than 0.6 meter. Wherever couplers, bends or similar fittings are used, the saddles shall be provided on either side at a distance as directed by the engineer-in-charge. Conduits shall be jointed by means of screwed couplers and screwed accessories only. In long distance, straight runs of conduit inspection type couplers or running type couplers with jamnut shall be provided. Threading shall be long enough to accommodate pipes to the full threaded portion of the couplers and accessories. Cut ends of conduits shall have neither sharp edges nor any burrs left to avoid damage to the insulation of the conductors. The cut ends/edges shall be filed before installation.

Bends in conduit run shall be done by bending conduits by pipe bending machine or any other suitable device as far as possible. Bends which cannot be made by a pipe bends shall be accomplished by introducing solid bends, inspection bends or cast iron inspection box. Not more than two equivalent 90° bends shall be used in a conduit run from the outlet to outlet.

All the conduit openings shall be properly plugged with PVC stoppers/ bushes. A breather-dRAINER shall be provided in the lowest position of the conduit system. The conduits shall be adequately protected against rust by applying two coats of approved synthetic enamel paint after the installation is completed.

Wherever conduits terminate into point control box, outlet box, distribution board, etc. conduits shall be rigidly connected to the box/board with check nuts on either side of the entry to ensure proper electrical and mechanical continuity.

b. Recessed Conduit System:

All the conduits including, bends, unions, junction boxes etc. shall be cleaned and painted with one coat of bituminous paint before they are fixed in position. Conduits which are to be taken in the ceiling slab shall be laid on the prepared shuttering work of the ceiling slab before concrete is poured. The conduits shall be properly threaded and screwed into sockets, bends, junction boxes, outlet boxes. The conduits in ceiling slab shall be straight as far as possible to facilitate easy drawing of wires through them. Before conduits are laid in the ceiling the position of outlet points, point control boxes, Junction boxes shall be set-out clearly so as to minimize offset and bends. Conduits recessed in walls shall be secured rigidly by means of steel hooks/ staples at intervals as directed by the engineer. Before conduit is concealed in the walls, all chases, grooves shall be neatly made to proper dimensions to accommodate the required number of conduits. The outlet for drawing wires and proper size earth continuity wire shall be run throughout the length of the conduit with the earth wire being efficiently fastened to the conduit by means of special clamps. Copper clamps shall be used for copper earth wire and GI clamps for GI wires.

1.4 CABLE TRUNKING/ RACEWAYS:

1.4.1 Cable trunking or raceways shall be of sheet steel construction or G.I. sheet. The thickness of sheet steel shall not be less than 16 gauge or as per Mentioned in S.O.Q. The sheet steel before fabrication shall be given a rigorous anticorrosive treatment. The trunking shall be provided with removable, covers of 1 meter length. The trunkings shall be supplied in suitable lengths. However, the maximum length of a single trunking shall not exceed 6 metre. The trunking shall be complete with 90° bends 145° bends,
adopters, tee-pieces, couplers etc. Removable cable retainers shall be provided wherever required.

1.4.2 INSTALLATION

Trunking/raceways shall be installed in readily accessible places. Trunking shall be supported at regular intervals of 1.0 metre to 2.0 metres as required. Trunking shall be aligned properly during the erection to present a neat appearance. Standard lengths of trunkings shall be jointed together by suitable couplers. Wherever required right angles bends, 145° bends, tees, etc. shall be provided in the run of cable trunk/raceways. Trunking shall be so arranged that not more than 30 cables run in any section. However, not more than 60% of cross-sectional area of the raceway shall be occupied by the conductors at any section. Trunking/raceways shall be bonded to the earth by a suitable size earth continuity conductor. Trunking shall be painted with two coats of approved synthetic enamel paint.

1.5 ENCLOSURE FOR ELECTRICAL ACCESSORIES:

Enclosure for electrical accessories such as switches, sockets, fan regulators, etc. shall be mild steel conforming to IS: 5133 Part-I. The dimensions of the enclosures shall be as per clauses 3.1 to 6.3.1 of IS: 5133. The wall thickness of MS enclosures shall be not less than 1.6mm wherever specially called for; galvanised sheet steel boxes shall be provided. The enclosure boxes shall be provided with a minimum of four fixing lugs located conveniently for fixing the covers. All fixing lugs shall have tapped holes to take machined brass screws.

1.5.1 Sufficient number of knockouts of 38mm/32mm/25mm/20mm dia shall be provided for conduit entries. Enclosures shall be sufficiently strong to resist mechanical damage under normal service conditions. Provisions shall be made for bonding the enclosures to the earth. The enclosures shall be adequately protected against rust and corrosion both inside and outside with suitable air drying paint. The enclosures shall be provided with 3mm thick phenolic laminated cover for mounting switches, sockets, etc. Wherever different phase conductors are brought into the same enclosure, phase barriers shall be provided. Phase barriers shall be of MS of hylam inserted in the box with slide-fit arrangement. Alternatively, boxes could be partitioned during construction.

1.6 WIRING CONDUCTOR

16.1. All wiring conductors shall be FRLS PVC insulated, standard copper conductors of 1100V Grade. Wiring conductors shall conform in all respects to IS: 694 (Latest Edition). Solid conductors may be used if specifically called for.

The current ratings for wiring conductors shall be based on the following parameters.

i. Ambient temperature - 40°C

ii. Conductor temperature - 70°C

Wiring Conductor shall be supplied in Red, Black, Yellow & Blue colours for easy identification of wires. The wiring conductors shall be supplied in sealed coils of
1.6.2 Installation of wiring conductors/ cables

The wiring conductors shall not be drawn into the conduits until the works of any nature that may cause damage to the wires are completed. Before drawing the wires the conduits shall be thoroughly cleaned, drained and ventilated. Proper care shall be taken in pulling the wires. The installation and termination of wires shall be carried out with due regard to the followings:

a. While drawing the wiring conductors, care shall be taken to avoid scratches and kinks which cause breakage of conductors. There shall be no sharp ends in the conduit system.
b. Insulation shall be shaved off like sharpening a pencil.
c. Strands of the wires shall not be cut for connecting to the terminals or lugs. The terminals shall have adequate cross section to take all the strands.
d. Ends of the wiring conductors shall be terminated by using crimping sockets. Soldering of sockets shall not be done unless otherwise approved by the engineer-in-charge.
e. Brass flat washers of large area shall be used for bolted terminals.
f. Bimetallic connectors should be used wherever copper conductors are tapped from aluminium mains or vice-versa.

1.6.3 Wiring for power and lighting circuits shall be carried out in separate and distinct wiring system. Wiring for emergency system shall also be carried out in a separate and distinct wiring system. Balancing of circuits in a three phase system shall be arranged before the installation is taken up.

1.6.4 The wiring system envisaged is generally shown on the layout drawing and line diagrams, however, a brief account of the general wiring system is given below:

a. Sub mains wiring - Wiring from switch boards to the individual distribution boards.
b. Circuit Wiring - Wiring from switch boards to the individual distribution boards.
c. Power Wiring - Wiring from DBs to the power socket outlets.

1.6.5 The sub main wiring shall be either in 3 Phase 4 wire, or Single Phase, 2 wire system. Each sub main wiring circuit shall also have its own copper earth continuity wire. The number and size of copper earth continuity wire. The number and size of copper earth continuity wire shall be as per the detailed drawings and specification.

1.6.6 Circuit wiring shall generally be of single phase however, a maximum of 3 to 4 single phase circuits belonging to the same phase/ pole could be installed in the same conduit or raceway. Each circuit wiring shall be provided with suitable copper earth continuity conductor as per Earthing specifications. Not more than ten light points/ fan points shall be grouped on one lighting circuit. The load per circuit shall not exceed 800 Watts. The minimum size of conductor for wiring of lighting circuits shall not less than 2.5sq.mm. in case of copper conductor. Power wiring shall not have more than two sockets connected to one circuit. 4.0sq.mm. copper conductors shall be used upto the power socket. All the wiring shall be carried out in looping-in-loop system. The maximum number of various size conductors that could be drawn in various sizes of conduits shall be as per table II of IS: 732 (Latest Edition). The wiring shall be colour coded for easy identification of phases and neutral. The following colour code shall be adopted.
Phase: R - Red
Y - Yellow/White
B - Blue

Neutral: - Black

Earth: - Green

1.6.7 All circuit wiring shall be provided with printed PVC identification ferrules at either and bearing the circuit number and designation.

1.6.8 The circuit wiring may be separately measured or included in point wiring as per the nomenclature given in BOQ equipment schedule/particular specifications.

1.7 SWITCHES, SOCKETS, SENSORS AND ACCESSORIES

1.7.1 General Requirements
Light control switches shall be 5A rating for controlling up to four light points and 16A rating for more than four light points. Light control switches shall be of modular type of poly carbonate with PVC moulded front plate & GI boxes design suitable for flush mounting for general lighting. Wherever specifically called for surface mounting.

1.7.2 All sockets 6A and 16A ratings shall be modular type flush mounting with control switches of the same rating as that of the sockets. All sockets shall be of poly carbonate with pins made of brass alloy and plated with a noble metal. Sockets shall be mounted on PVC moulded front plate & GI boxes.

1.7.3 Industrial type Sockets
Industrial type sockets shall be provided wherever specifically called for. Industrial sockets shall be totally metal clad with porcelain base incorporating the pins. Socket shall have 3Pins for single phase application and 5pins for 3 phase application. The sockets shall be provided with suitable metal clad plug top with suitable cable entry. Sockets shall have metal covers with chain. Industrial type sockets shall be provided with a suitable sheet steel housing made of 16 Gauge with the sockets mounted in flush with cover of the housing.

1.7.4 Lamp holders, ceiling roses, etc.
Accessories for light outlets such as lamp holders, ceiling roses, etc. shall be in conformity with requirements of relevant IS specifications. Only approved make of accessories shall be supplied, if required.

1.7.5 Installation of Switches, sockets and accessories
All the switches shall be wired on phase. Connections shall be made only after testing the wires for continuity, cross phase etc. with the help of a megger. Switches, sockets, fan regulator etc. shall be housed in proper GI boxes with PVC moulded front plate.
covers. Regulators shall be fixed on adjustable MS flat straps inside the enclosure. The arrangement of switches and sockets shall be neat and systematic, fixed to the enclosure in plumb with counter sunk head. For wall plug sockets, the conductors shall be terminated directly into the switches and sockets. The outlets, point control boxes etc. shall be set out as shown on the drawings. Before fixing these, the contractor shall obtain clearance from the engineer-in-charge with regard to their proper locations. The enclosures of sockets/ and 3rd pin of the sockets shall be connected to the ground through a proper size earth continuity wires as laid out in specification of earthing section.

1.7.6 Sensors
Lighting control for the common area, corridors, Toilets should be done through Occupancy sensors for the energy conservation, daylight/Lux sensors will be required as per the BOQ.

1.8 LUMINAIRES

1.8.1 General
All the materials used in the construction of luminaires shall be of such quality, design and construction that will provide adequate protection in normal use, against mechanical, electrical failures/ faults and exposure to the risk of injury or electric shock and shall withstand the effect of exposure to atmosphere.

1.8.2 Fluorescent lamp luminaires
Luminaires shall be supplied as per the design specified in the schedule of quantities (S.O.Q.). Luminaires shall be complete in all respects with basic mounting channel, shock proof insert contact rotor lamp holders, starter with holder, polyester ballast, connector block, internal wiring and decorative attachments, if any. The mounting channel shall be made of mild steel sheet suitably rust inhibited and stove enamelled. A dust proof cover stove enamelled to white shade shall be provided from the channel to protect the accessories and wiring from dust and vermin and to act as reflector. Ballast shall be silent in operation. Ballast shall have a long life and shall be highly reliable. A suitable capacitor to improve the power factor of luminaires to at least 0.9 lag shall be provided. Capacitors shall be hermetically sealed.

Diffusers, louvers, etc shall be of opal acrylic or polystyrene diffusers, louvers, and similar decorative attachments. The attachments shall be guaranteed against decolourization, warping and deformation under continuous operation. Fluorescent lamps shall conform to BS: 1853 in all respects. Fluorescent lamps shall be of bi-pin pattern. The colour of the light shall be white or cool day light, as required. Unless otherwise specified, the lamps shall be of 40W, 36W or 28W and 1200mm long. Luminaires shall be provided with an earthing terminal for bonding the body of the luminaire to earth. Luminaires shall be installed as specified on the drawing. Wherever luminaires are fixed on the false ceiling, suitable supporting and fixing arrangements independent of the frame work of false ceiling shall be provided. Suspended luminaires shall be provided with swivel type hangers, comprising of suspension pipes, swivel sockets, screws, bolts etc., for installing the luminaires. Luminaires shall be suspended true to alignment, plumb and level and capable of resisting all lateral and vertical forces. Lead-in-wires shall be protected from abrasion. Erection of fixtures shall include
assembling of all components of the fixtures such as chokes, condensers, starters, decorative attachments, etc.

1.8.3 Incandescent lamp luminaires

Incandescent lamp luminaires shall be supplied as per the design and type mentioned in the schedule of quantities (S.O.Q.). Incandescent lamp luminaires shall be provided with lamp holders suitable for lamps with standard bayonet cap upto 200 watts. For luminaires suitable for lamps above 200 Watts, holders to suit Edison screw or Goliath screw caps shall be provided with lamp holders with cord grips. Incandescent lamp luminaires shall be complete with reflector shade, decorative attachment (if any) and cover as specified any required. Incandescent lamps shall conform in all respects to BS: 161.

1.8.3 Light Track

Light tracks, wherever required, shall be suitable for flush mounting with all mounting accessories. The light track shall consist of an extruded aluminium section with two insulated copper conductors on either side, tack adopter/current collectors for fixing the luminaires, and the accessories. Live end and couplers shall be die-cast aluminium with injection moulded ends, cover and connectors. The current collector/adopter fitting shall be suitable for sliding on the light track with locking arrangement in any position for engaging the live conductors and earthing the track adopter/ current collector.

1.9 FANS

1.9.1 Ceiling fans

Ceiling Fans shall conform to IS: 374 (Latest Edition) all respects fan shall be smooth and silent in operation. The fan motor shall be a capacitor type motor with internal starter and external rotor pattern. The blades shall be made of aluminium sheets painted in off white shade. The design and construction of blades shall be such that maximum quantity of air is displaced in smooth manner. The motor and blades shall be statically and dynamically balanced. The fans shall be provided with ball bearing which is accessible for lubrication. The ceiling fan shall be provided with rubber shackle and a down rod of at least 12" long. The suspension arrangement shall be jointed to the fan motor by means of a thread joint and a safety locking arrangement. Fans shall be provided with bottom cover and a top canopy. A regulator for 5 speed operation and stop shall be provided with every fan. Electronic stepless regulators shall be provided, if specified. Ceiling fans shall be suspended from the special hooks or special fan hook boxes. Where hooks are used the wiring to the fan shall be from a ceiling rose. Wherever special fan hook boxes are used, the fan wiring shall be terminated in porcelain/ PVC auto way connector. Lead-in-wires shall have cross-section area of not less than 1.5mm (Copper).

1.9.2 Exhaust Fans

Propeller type exhaust fan shall conform to IS: 2312 (Latest Edition) in all respects. The motor shall be of die cast aluminium case. The fan motor shall be of sq. cage induction
design. Single phase motors shall be capacitor-start and run type. Exhaust fans be provided with a special anticorrosive treatment to withstand normal concentrations of chemical fumes in the environment.

The fan shall be designed to withstand the effects of moisture under normal conditions of use. The design of motor and its windings shall be such that moisture in surrounding is not absorbed by the winding. Exhaust fans shall be complete with mounting rings, ring arms and a resilient suspension. The motor and blades shall be statically and dynamically balanced. The blades shall be of mild steel sheets and so designed that they operate smoothly with minimum noise. The fans shall be finished to be a glossy gray shade with approved enamel paint. The fans shall also be provided with gravity louvers for exhaust arrangement or bird screen for inlet arrangement.

Exhaust fans shall be fixed at the locations shown on the drawings. The fans shall be fixed by means of rag bolts grouted in wall. Exhaust fan be connected to the exhaust fan point by means of a flexible cord.

1.10 POINT WIRING

Point wiring shall commence from the first point control box/ local control box for the points connected to the same circuit. Point wiring for lights, fans, 5A sockets, call bells, etc. shall be carried out with copper conductor PVC insulated wires of 1.5 sq.mm cross section or as per SOQ. The point wiring shall be inclusive of 20mm/ 25mm/ 32mm sheet steel conduits of standard and approved make (as specified herein-before) along with approved quality conduit accessories such as bends, inspection bends, reducers, junction boxes, etc. together with wiring accessories such as switches, ferrules, PVC bushes, connectors, point control boxes (enclosure for electrical accessories) etc. point wiring shall be provided with 1.5sq. mm. PVC insulated copper earth continuity wire for earthing 3rd point of sockets, luminaries and fan fixtures. Light control shall be either single, twin or multiple points controlled by a switch as specified.

1.11 TESTING AND ELECTRICAL INSTALLATION

1.11.1 Testing and installation shall be as per IS: 732-1963

a. The insulation resistance shall be measured by applying between earth and the whole system of conductors or any section thereof with all fuses in places and all switches closed and except in earthed concentric wiring all lamps in position or both poles of the installation otherwise electrically connected together, where a direct current pressure of not less than twice the working pressure, provided that it need not exceed 500 Volts for medium voltage circuits. Where the supply is derived from the three wires (A.C. or D.C) or a poly phase 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 outer or phase conductor and the neutral.

b. The insulation resistance measured as above shall not be less than 50 divided by the number of points on the circuits provided that the whole installation shall be required to have an insulation resistance greater than one meg-ohm.
c. Control rheostats, hearing and power appliances and electric signs may, if required, be disconnected from the circuit during the test, but in event the insulation resistance between the case of frame work and all live parts of each rheostat appliance and sign shall not be less than that specified in the relevant Indian Standard Specification or where there is no such specification shall not be less than half a meg-ohm.

d. The insulation resistance shall also be measured between all conductors connected to one pole or phase conductor of the supply and all the conductors connected to the middle wire or the natural or to the other pole or phase conductors of the supply and its value shall not be less than specified in sub-clause (b).

e. On completion of an electric installation (or an extension to an installation) a certificate shall be furnished by the Contractor countersigned by the certified supervisor under whose direct supervision the installation was carried out. The certificate shall be in prescribed form as required by the local electric supply authorities.

1.11.2 Testing of earth Continuity Path
The earth continuity conductor including metal conduits and metallic boxes / enclosure of in all cases shall be tested for electric continuity and the electrical resistance of the same along with the earthing lead but excluding any added resistance or leakage circuit breaker measured from the connection with the earth electrodes to any point in the earth continuity conductor in the completed installation shall not exceed one meg-ohm.

1.11.3 Testing of polarity of non-linked single pole switches
a. In a two wire installation a test shall be made to verify that all non linked single pole switches have been fitted in the same conductor throughout and such conductor shall be labelled or marked for connection to an outer on phase conductor or to the non-earthed conductor of the supply.

b. In a three wire or four wires installation a test shall be made to verify that every non-linked single switch is fitted in a conductor which is labelled, marked for connection to one of the outer phase conductor of the supply.
GENERAL SPECIFICATION FOR: EARTHING FOR ELECTRICAL WORK

1.1 General

All non-current carrying metal parts of the electrical installation shall be earthed as per IS: 3043. All metal conduits, trunkings, cable armour, switchgear, distribution boards, meter, light fixtures, fans and all other metal parts forming part of the work shall be bonded together and connected by two separate and distinct conductors to earth electrodes. Earthing shall also be in conformity with the provisions of Rules 32, 61, 62, 67 & 68 of IER 1956. These specifications apply to both copper and GI earthing system. The material to be used shall be as per that give in SOQ.

1.2 Earthing Conductors

1.2.1 All earthing conductors shall be of high conductivity copper or GI and shall be protected against mechanical damage and corrosion. The size of earth conductors shall not be less than half that of the largest current carrying conductor. The connection of earth continuity conductors to earth bus and earth electrodes shall be strong and sound and shall be easily accessible. The earth tapes shall be joined together using double rivets. The earthing conductor shall be laid in cable trenches, cable trays or conduits or on cable by using suitable clamps made of non-ferrous metals compatible with the earthing conductor. The following earthing conductors are required to be used for various sections of the installations.

a. All fixtures - lighting, fan and switch enclosures, lighting conduits shall be earthed with 16 SWG bare copper wire or 1.5 sq.mm. Copper conductor, PVC insulated wires or 16 SWG GI wire. (As per SOQ)
b. 3rd pin of power socket outlets upto 20A shall be earthed with 1.5 sq.mm. copper conductor PVC insulated wire (As per SOQ)
c. All single phase switches and DBs above 20A and upto 30A rating shall be earthed with one run of 10SWG bare copper wire or 2.5 sq.mm copper conductor PVC insulated wire or GI wire.
d. All single phase switches and DBs above 30A and upto 63A rating shall be earthed with one run of 8SWG bare copper wire or 4 sq.mm copper conductor PVC insulated wire or GI wire.
e. All three phase switches/ DBs upto 30A rating shall be earthed with 2 runs of 10SWG copper wire or 2.5 sq.mm copper conductor PVC insulated wire or GI wire.
f. All three phase switches/ DBs above 30A and upto 63A shall be earthed with 2 runs of 8SWG copper wires or 4 sq.mm copper conductor PVC insulated wire or GI wires.
g. All three phase switches/ DBs above 63A and upto 100A shall be earthed with 2 runs of 25x3mm Copper Strip/ GI Strip.
h. All three phase switches/ DBs of 200A rating and above shall be earthed with 2 runs of 25x6mm copper Strip / GI Strip.
i. All motor frames shall be earthed by two earthing conductors of specified cross section.

Earth conductors shall be properly terminated with bolts to the frames of panels/equipments and provided with crimped sockets in case of wires.
1.2.2 Main earth bus shall be taken from the main medium voltage panel to the earth electrodes. The number of electrodes required shall be arrived at taking into consideration the anticipated fault on the medium voltage net-work and soil resistivity.

1.2.3 All the sub mains and sub circuits shall be provided with earth continuity conductors as specified and connected to the main earth bus. Earthing conductors for equipment shall be run from the exposed metal surface of the equipment and connected to a suitable point on the sub main or main earthing bus. All switches shall be connected through double earthing conductor to the earth bus. Earthing conductors shall be terminated at the equipment using suitable lugs, bolts, washers and nuts.

1.2.4 All conduits, cable armouring, raceway, rising mains, etc. shall be connected to the earth all along their run by earthing conductors of suitable cross sectional area. LPG pipes, water pipes, steel structural elements, cable trays/ racks lighting conductors shall not be used as a means of earthing an installation. The electrical resistance of earthing conductors shall be low enough to permit the passage of fault current necessary to operate a fuse/ protective device a circuit breaker and shall not exceed 2 ohms. As rough guide the following sizes of earth continuity conductors shall be used for circuit wiring.

<table>
<thead>
<tr>
<th>Size of circuit wires/ cables</th>
<th>Size of copper or GI earth wires</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. 2.5 sq.mm.</td>
<td>16 SWG or 1.5sq.mm. Cu. PVC insulated</td>
</tr>
<tr>
<td>b. 4 sq.mm.</td>
<td>14 SWG or 2.5sq.mm. Cu. PVC insulated</td>
</tr>
<tr>
<td>c. 6 sq.mm.</td>
<td>12 SWG or 2.5sq.mm. Cu. PVC insulated</td>
</tr>
<tr>
<td>d. 10 sq.mm./ 16 sq.mm.</td>
<td>8 SWG or 4.0sq.mm. Cu. PVC insulated</td>
</tr>
<tr>
<td>e. 25 sq.mm. / 35 sq.mm.</td>
<td>6 SWG or 6.0sq.mm. Cu. PVC insulated</td>
</tr>
</tbody>
</table>

All Single phase wiring shall have one run of earth wire and three phase wiring shall be provided with two runs of earth wires.

1.3 EARTHING ELECTRODES: (REFER IS : 3043)

1.3.1 Earthing electrodes shall be designed as per the requirements of clause 17.2 of IS : 3043. The number and size of earth electrodes shall be calculated so that under fault conditions no electrode is loaded above its maximum permissible current density. The resistance of earth electrode shall be as low as possible, the maximum allowable value being one ohm. Earthing electrodes of either plate of pipe electrode shall be decided according to the anticipated fault level of the net-work and local soil conditions. Generally, plate electrodes shall be used for sub-stations and large & medium voltage net work and pipe electrodes for small & medium voltage net-work and installations.
1.3.1 Plate Electrode (REFER IS: 3043)

Plate electrode shall be made of copper plate of 3.15mm thick and 60x60 cm. Size or as per S.O.Q. The plate shall be buried vertically in ground at a depth of not less than 2 meters to the top of the plate, the plate being encased in charcoal to a thickness of 15cm all round. It is preferable to bury the electrode to a depth where sub soil water is present. Earth leads to the electrode shall be laid in a GI pipe and connected to the plate electrode with brass bolts, nuts and washer. GI pipe of not less than 19mm dia shall be placed vertically over the plate and terminated in a funnel at 5cm above the ground. The funnel shall be provided with wire mesh. The funnel shall be enclosed in masonry chamber of 30cm x 30cm x 30cm dimensions. The chamber shall be provided with CI frame and CI cover. The earth station shall also be provided with a permanent identification label/ tag.

1.3.3 Pipe Electrode (REFER IS: 3043)

Pipe electrode shall comprise of a 4.5 meter long 75mm dia GI pipe or as per S.O.Q. with holes drilled as per IS: 3043 and buried vertically in a pit of 35cm x 35cm size and filled with alternate layers of charcoal, salt and river sand and connected at the top to a GI pipe of 19mm, 1 metre long with a funnel at the other end, 5cm above ground. The earth lead shall be properly clamped to the pipe electrode with brass bolts, nuts and washers. The funnel and earth lead connection shall be enclosed in a masonry chamber of 30cm x 30 cm x 30cm dimensions. The chamber shall be provided with a CI frame and CI cover. Proper permanent identifications tag/ label shall be provided for each electrode.

1.4 PRECAUTIONS:

1.4.1 Earthing system shall be mechanically robust and the joints shall be capable of retaining low resistance even after passages of fault currents.

1.4.2 Joints shall be soldered, tinned and double riveted in case of copper and joints shall be filed and doubled riveted in case of GI. All the joints shall be mechanically, electrically, continuous and effective.

1.5 TESTING:

1.5.1 On the completion of the entire installation, the following tests shall be conducted.

a. Earth resistance of electrodes.

b. Earth loop impedance as per IS: L 3043/NEC.

1.5.2 All meters, instruments and labour required for the tests shall be provided by the contractor. The results shall be submitted in triplicate to the engineer-in-charge for approval.

1.6 SUB-STATION AND GENERATOR EARTHING

i. H.T panels and transformer body shall be provided with double earthing with copper/ GI tape of suitable size depending upon the anticipated fault level. The contractor shall
furnish detailed calculations in respect of the size of earth conductors and number of earth stations.

**SPECIFICATIONS FOR MAINTENANCE FREE EARTHING**

**Grounding System – Electrolytic Maintenance Free Earthing**

The effective earthing connection surface should be smooth and free form paints and oxide coatings.

**A. General**

1. Self-contained ground electrode(s) using electrolytically enhanced grounding where specifically indicated on the drawings.

2. The electrode shall operate by hygroscopic ally extracting moisture form the atmosphere to activate the electrolytic process.

3. Electrode shall be UL® Listed

4. Electrode shall be 100% self-activating, sealed and maintenance free. No additions of chemical or water solutions required.

**B. Technical Specifications**

**Type and Technical Specifications (Long Life Maintenance Free Earthing Solution)**

<table>
<thead>
<tr>
<th>Type</th>
<th>Soil</th>
<th>Warranty (Years)</th>
<th>Current Capacity</th>
<th>Electrode Details</th>
<th>Back Fill Qty (Bags)</th>
<th>Test Well Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrolytic Earthing</td>
<td>Rocky</td>
<td>20/30</td>
<td>1 kA/9Se</td>
<td>Length (feet)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Outer (inch)</td>
<td>Thickness (mm)</td>
<td>Polyplastic</td>
</tr>
</tbody>
</table>

**Note:** Each Bags Contain 22.6 Kg materials.

1. The specifications with performance warranty and technical spec details shown in the tables.

2. The ground rod shall be filled from the factory with non-hazardous metallic salts to form the electrolytic process and enhance the grounding performance.

3. Ground rod shall be a minimum of ten feet long.

4. 2Nos 40x5 mm GI Strip at the top of the electrode for the connections and inspection purpose.
C. **Protective Test Well**

1. Polyplastic well for non-traffic applications. Includes bolt down flush cover with “breather ports”

D. **Environment Friendly Backfill Material**

1. Non-corrosive, electrically conductive and ground enhancing backfill. Backfill will lower the contact resistance to earth by up 63% when in conjunction with copper grounding equipment.

2. No mixing or tamping shall be required for backfill application.

E. **Excavation**

1. Bore a hole into the earth (minimum diameter 6”) Hole should be bored to allow installed unit to be as close to vertical as possible.

2. A 14” Hole must be provided for the cover box.

3. Depth of hole must be 6” deeper than the vertical length of the system.

4. Top vent ports must be left open to the atmosphere for continuous air circulations by using the protective test well provided.

F. **Installation**

1. Remove sealing tapes from bottom of unit only. Tapes must be saved and made available to the electrical inspector to verify removal and proper installation. Do NOT remove the green and white “Bury to Here” marker from the top of the unit.

2. Position the unit in the hole. Use green and white “Bury to Here” marker as a guide to depth in which unit shall be buried in TerraFill®. Three bags of TerraFill® are included with each 10’ electrode.

3. Pour BackFill® (Each bag contain 22.6Kg Materials) around electrode in augured hole. Do not mound backfill past green and white marker.

4. Place box with cover over the top of the electrode so that the cover is at grade level. Use backfill to stabilizer box around the electrode. This keeps the breather holes free of obstructions and debris. Top of box should not contact the top of the electrode.

5. Remove top sealing tape ONLY after backfill is complete. This prevents soil from blocking the vent ports.

D. **Connection**

1. Connect grounding conductor to ground rod pigtail exothermally/ Stainless steel nut and bolts.

2. Burry grounding conductor 30inch below grade.
SPECIFICATION LIGHTING PROTECTION SYSTEM

EXTERNAL LIGHTNING PROTECTION SYSTEM AS PER INDIAN STANDARDS (IS/IEC 62305-3 & NBC-2016)

**General**

There are no devices or methods capable of modifying the natural weather phenomena to the extent that they can prevent lightning discharges. Lightning flashes to, or nearby, structures (or lines connected to the structures) are hazardous to the structures, their contents and installations as well as to lines. This is why lightning protection measures are essential.

Lightning Protection System shall be in accordance with IS IEC 62305-3 & NBC-2016. Lightning Protection consists of external Protection for the building with Air termination, Down Conductors and Earthing and Internal protection for power lines with Surge Protective devices.

Generally lightning between cloud and ground creates failures. However inter-cloud and intra-cloud lightning also can create potential differences and failures in electronic installation. More than 95% of Lightning strikes are of Negative impulse and less than 5% are of positive impulse. Positive impulses are mainly due to dry lightning in cold areas.

Current parameters as per IS/IEC 62305 and the effects of lightning are as below

<table>
<thead>
<tr>
<th>Current Parameters</th>
<th>Symbol</th>
<th>Unit</th>
<th>Lightning Protection Level</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td><strong>First positive Impulse</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak Current</td>
<td>I</td>
<td>kA</td>
<td>200</td>
<td>150</td>
</tr>
<tr>
<td>Impulse charge</td>
<td>QSHOR T</td>
<td>C</td>
<td>100</td>
<td>75</td>
</tr>
<tr>
<td>Specific Energy</td>
<td>W / R</td>
<td>MJ/Ω</td>
<td>10</td>
<td>5.6</td>
</tr>
<tr>
<td>Average Steepness</td>
<td>di / dt</td>
<td>kA / µS</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>Time Parameters</td>
<td>T1 / T2</td>
<td>µS / µS</td>
<td>10/350</td>
<td></td>
</tr>
</tbody>
</table>

**First Negative Impulse**
Damages from lightning strike are due to Peak Current (I), Charge (C), Specific Energy (W/R) & Rate of change of current (di/dt). Lightning protection is designed to take care of these effects of lightning and hence the following parameters shall be strictly followed.

Effect of Lightning on External LPS (Air termination, Down Conductor and Earthing)

Effects on air-termination systems arise from both mechanical and thermal effects. Effects on down-conductors are thermal effects due to resistive heating & mechanical effects in parallel conductors and in Bends. The real problems with earth-termination electrodes are linked with chemical corrosion and mechanical damage caused by forces other than electro dynamic forces.

Sizing and fixing of Materials are selected to handle the mechanical and thermal effects. Bends in down conductor shall strictly NOT be at 90 degree (right angles) & should have a curved path of 45 degree bend. Earth electrodes are selected based on the current handling capacity up to 1 second. To avoid corrosion problems as explained in IS/IEC 62305 (clause E.4.3.4 and E.5.4.3.2), GI is strictly not recommended inside concrete and in soil.

Effect of Lightning on Internal LPS (SPD’s for POWER, DATA lines etc)

Effect on internal LPS is mainly due to coupling and the rate of change of current. Due to Very high di/dt of the first negative stroke. The expected problem is the response time of SPD and the voltage drop in the connecting wires. SPD’s at the incoming panels shall have a response time less than 1 nano sec & shall be of BUSBAR Mounted type to avoid connecting wire length.

LPL (Lightning Protection Level)

LPL is a number associated with a set of lightning current parameters relevant to the probability that the associated minimum & maximum values do not exceed the normally occurring lightning. LPL can be determined by Risk analysis as explained in IS IEC 62305-2 or can be selected based on the guideline in NBC-2016.

<table>
<thead>
<tr>
<th>Application</th>
<th>LPL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Data Centers, Military Applications, Nuclear Power Stations, High raise Hotels/Hospitals, airports, essential services such as telecom towers</td>
<td>1</td>
</tr>
<tr>
<td>EX-Zones in the industry and chemical sector, Low raise Hospitals &amp; Hotels, fuel retail outlets, gas station, compressor station etc</td>
<td>2</td>
</tr>
</tbody>
</table>
LPL levels, probability and basic design consideration:

<table>
<thead>
<tr>
<th>Class of LPS</th>
<th>Lightning Current MINIMUM</th>
<th>Lightning Current MAXIMUM</th>
<th>Interception probability</th>
<th>Rolling sphere radius</th>
<th>Mesh size (m)</th>
<th>Down Conductor Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3 kA</td>
<td>200 kA</td>
<td>98%</td>
<td>20</td>
<td>5*5</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>5 kA</td>
<td>150 kA</td>
<td>95%</td>
<td>30</td>
<td>10*1</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>10 kA</td>
<td>100 kA</td>
<td>88%</td>
<td>45</td>
<td>15*1</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>16 kA</td>
<td>100 kA</td>
<td>81%</td>
<td>60</td>
<td>20*2</td>
<td>20</td>
</tr>
</tbody>
</table>

Protection angle w.r.t Height

Air termination system:

Material, Configuration and Minimum cross sectional area of air terminal & down conductors
Air Termination mesh conductor and down conductors: 8 mm Aluminium alloy round conductor (50 mm2)

Air Termination Rod: 10 mm, 16 mm & 40 mm solid Aluminium rods (combination of sizes) (tubes are not allowed)

Joints / Connectors / Fixing materials:

<table>
<thead>
<tr>
<th>Connection materials</th>
<th>Connector type</th>
<th>GI fixing materials shall not be used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium to Aluminium</td>
<td>Aluminium or SS</td>
<td></td>
</tr>
<tr>
<td>Aluminium to Steel</td>
<td>SS</td>
<td></td>
</tr>
</tbody>
</table>

Aluminium accessories if connection is between Aluminium materials are necessary. SS accessories if connections are between aluminium and copper / copper coated materials.

Earth Termination Conductor: 10 mm solid copper coated steel conductor (100 microns min coating)

Earth Termination Joints in soil: Exothermic welding

GI material for earthing shall not be used as per the recommendation in IS/IEC62305.

If the structure height is more than 60 meters, top 20% of the height of the structure shall be protected with a lateral air termination system. This is needed because the probability of flashes to the side is generally more for structures more than 60 meters in height. More importance need to be provided to Corners, Edges and significant protrusions such as balconies. Metallic handrails/ Aluminium frame of wall cladding if used in balconies shall be connected to air termination / down conductors.

In PEB / Steel buildings where GI sheet roofing, air termination mesh / Rod shall be directly mounted on the sheet. Fixing materials used shall be in good electrical contact with the sheet, shall not create water leakage.

No drilling is allowed in the terrace for fixing the air terminal, if the roof is made of concrete. Parapet wall is exception to this.

**Air terminal holder:**

Concrete Roof structure: Conductors shall be securely fixed on the terrace by means of concrete air terminal holders with suitable fixing materials which is fixed on the roof by adhesive or cement mortar taking care of varying weather conditions. Plastic air termination conductor holder is not allowed. The minimum height of this air terminal holder shall be 50 mm to avoid the contact of conductor with water.

Metal Roof structure: Conductors shall be securely fixed on the terrace by means of air terminal holder which is fixed on the roof by metal conductor holder made of Stainless
steel. As metal roof structures are normally tapered at an angle, there are no min height criteria for metal conductor holder.

Recommended fixing distance of air terminal and down conductors

<table>
<thead>
<tr>
<th>Arrangement</th>
<th>Recommended distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAPE / Strip</td>
<td>ROUND</td>
</tr>
<tr>
<td>Horizontal conductor on horizontal surface</td>
<td>500 mm</td>
</tr>
<tr>
<td></td>
<td>1000 mm</td>
</tr>
<tr>
<td>Horizontal conductor on vertical surface</td>
<td>500 mm</td>
</tr>
<tr>
<td></td>
<td>1000 mm</td>
</tr>
<tr>
<td>Vertical conductor from Ground to 20m height</td>
<td>1000 mm</td>
</tr>
<tr>
<td></td>
<td>1000 mm</td>
</tr>
<tr>
<td>Vertical conductor above 20m height</td>
<td>500 mm</td>
</tr>
<tr>
<td></td>
<td>1000 mm</td>
</tr>
</tbody>
</table>

If antenna, Chillers or any other roof top electrical equipment is present in terrace, the same have to be protected by using vertical air terminal after calculating the safety or separation distance. The vertical air terminal has to have suitable supports to hold it. Wind speed need to be taken into account. Vertical air terminal must be connected to horizontal air terminal by using suitable connectors.

At the crossings of the horizontal air terminals, suitable Cross connector has to be used.

Safety or Separation distance: (not required for LPS using structural natural components)

To avoid flash over to electrical/electronic apparatus, this equipment shall be kept at a distance away from LPS components more than the safety distance as per the following calculation.

Safety/Separation distance (S) in m = \((k_i \times k_c \times L) / km\)

Coefficient \(k_i\) depends on class of LPL/LPS (\(k_i = 0.08\) for LPL1, 0.06 for LPL 2, 0.04 for LPL3 and 4)

Coefficient \(k_c\) depends on no of down conductors: \(k_c = 0.66\) for 2 down conductors, \(k_c = 0.44\) for 3 or more down conductors

Value of coefficient \(k_m = 1\)

Value of L is the total distance between the equipment to be protected (for e.g. Antenna) to the equi-potential bonding bar situated just above the ground.

**Expansion piece**

In order to take care the expansion of the metal in summer and contraction of the metal in winter, expansion piece with suitable connectors have to be used at every 20m distance of horizontal air termination mesh.

**Joints and Bends**
The lightning protective system shall have few joints as far as possible & air terminal & down conductor have to be straight. Where it is not possible, it should NOT be bent at 90 degree (right angles) & should have a curved path of 45 degree bend.

Down conductor system

In order to reduce the probability of damage to electronic/electrical equipment, the down conductors shall be arranged in equi distance in such a way that from the point of strike to earth, several parallel current paths should exist & length of the current path should be minimum. Down conductors should be installed at each exposed corner of the structure as a minimum. Maximum distance between down conductors shall be as per the table above.

Test joints:

At the connection to the earth conductor, a test joint should be fitted on each down conductor at a height of 1 m from the ground, except in the case of natural down conductors combined with foundation earth electrode. The purpose of test joint is to measure the earth resistance value. The remaining portion of down conductor (i.e., after the test joint should be mounted inside a plastic pipe of minimum 3 mm thickness.)

Earth Terminations

For earth termination system, 2 basic types of earth electrode arrangements are applicable. Type A & Type B arrangement.

Type A arrangement: Comprises of horizontal or vertical earth electrode installed outside the structure to be protected connected to each down conductor. Minimum Length of vertical earth electrode shall be as below

<table>
<thead>
<tr>
<th>Class of LPS</th>
<th>Typical Length of each vertical earth electrode based on Soil resistivity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Up to 500 Ω M</td>
</tr>
<tr>
<td>1</td>
<td>2.5 meter</td>
</tr>
<tr>
<td>2</td>
<td>2.5 meter</td>
</tr>
<tr>
<td>3</td>
<td>2.5 meter</td>
</tr>
<tr>
<td>4</td>
<td>2.5 meter</td>
</tr>
</tbody>
</table>

If horizontal electrodes are used, the length shall be double. In type A arrangement, the total number of earth electrodes shall not be less than two. Type A arrangement is suitable in places where electronic equipment are not located.

Type B arrangement: This type of arrangement comprises either a ring conductor external to the structure to be protected, in contact with the soil for at least 80% of its total length or a foundation earth electrode. Ring earthing must be 1 meter away from the building and 0.5m below the ground as a closed loop. Such earth electrodes can also be meshed.
For structures with extensive electronic systems or with high risk of fire, type B earthing is most preferable method. There is no limit in the resistance of Ring Earthing if the ring radius of the ring is larger than 50 meters or 80 meters for LPL 1 and 2. For LPL 3 and 4 this radius is about 5 meters. The overall resistance of earthing system shall not exceed 10 ohms.

Galvanised steel (GI) as earthing material shall not be used.

Lightning Counters: At least 2 down conductors in an installation shall have a lightning counter tested as per IEC 62561. The counter shall be digital type with replaceable battery. Battery life shall be minimum 3 years. The minimum measuring current is 1KA (8/20) and the maximum is 100 KA (10/350). The counter shall be outdoor type, IP65 and shall be able to record date, time and no of strikes.

Quality and Confirmations

All materials and accessories shall be tested as per IEC 62561 for its mechanical / corrosion resistant / electrical conductivity. Vendor shall provide test reports along with completion certificate. GI (Hot dip galvanised or zinc electroplated) fixing materials and fasteners are not allowed.

References:

IS/IEC62305 – PROTECTION AGAINST LIGHTNING:

Part 1: General Principles

Part 2: Risk Management

Part 3: Protection of structures

Part 4: Protection of Electrical & Electronic equipment within structure


LIFE SAFETY / FIRE DETECTION SYSTEM

GENERAL DESCRIPTION:

a. Provide Fire Detection and Alarm System in accordance with NFPA 72 (Latest edition) and requirements of the Contract Documents. Provide a complete operable and intelligent analog addressable Fire Alarm and Detection System with associated communication and notification systems. The system shall include interfaces for foreign systems, as described herein and in accordance with the Contract.
b. All Plant furnished shall be new and the latest state-of-the-art, products of a single 
Manufacturer engaged in the manufacturing of analog fire detection devices for at least 5 years.

c. All software licenses shall be supplied as part of the contract. Renewable & subscription license 
are not acceptable.

d. The system shall be supplied, installed, tested, and approved by the local Authority Having 
Jurisdiction, and turned over to the

Contractor in an operational condition.

e. The subcontractor shall contract with a single supplier for the fire alarm Plant, engineering, 
programming, inspection and tests, and shall provide a “UL Listing Certificate” for the complete system.

f. Drawings: The Drawings shall serve to indicate the general arrangement of the various Plant 
and their generic functional interconnections. However, layout of Plant, accessories, specialties, 
conduit system and wiring, are diagrammatic and do not necessarily indicate every required 
device, fitting, etc., required for the complete installation.

**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 which ever 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 BUILDING CODES 2016**

IS CODES with latest amendments

**APPROVALS:**

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

**UL Underwriters Laboratories Inc (9th Edition)**

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 backboxes, except where conduit entry is specified by the FACP manufacturer.

Conduit shall be 3/4-inch (19.1 mm) minimum.

Wire:

All fire alarm system wiring shall be new.

Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for Initiating Device Circuits and Signaling Line Circuits, and 14 AWG (1.63 mm) for Notification Appliance Circuits.

All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.

**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 system 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 80-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 system 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 80-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 system 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**

1. 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 640-character 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/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 6 inch or 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.

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. Sounders installed will automatically activate 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 meet 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 broadcast 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, prealarms, disabled points and activated points, all installed points filtered by SLC points, panel circuits, logic zones, annunicators, 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 LCD. Activation of a NON-FIRE point shall activate control by event logic but shall not cause any indication on the control panel.

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

d. 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.

e. 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 agent 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 standards, 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 6 inch or 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.

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 640-character LCD.

**Loop (Signaling Line Circuit) Control Module:**

1. The Loop Control Module shall monitor and control a minimum of 256 intelligent addressable devices and additional capacity for Loop Cable Isolators. This includes 127 intelligent detectors, 127 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 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 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 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 120/240 VAC, 50/60 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.

**Auxiliary Addressable Power Supply**

1. The auxiliary addressable power supply is a remote 24 VDC power supply used to power Notification Devices and field devices that require regulated 24VDC power. The power supply shall also include and charge backup batteries.

2. The addressable power supply for the fire alarm system shall provide up a minimum of 6.0 amps of 24 volt DC regulated power for Notification Appliance Circuit (NAC) power or 5 amps of 24 volt DC general power. The power supply shall have an additional .5 amp of 24 VDC auxiliary power for use within the same cabinet as the power supply. It shall include an integral charger designed to charge 7.0 - 25.0 amp hour batteries.

3. The addressable power supply shall provide four individually addressable Notification Appliance Circuits that may be configured as two Class "A" and two Class "B" or four Class "B" only circuits. All circuits shall be power-limited per UL 864 requirements.

4. The addressable power supply shall provide built-in synchronization for certain Notification Appliances on each circuit without the need for additional synchronization modules. The power supply's output circuits shall be individually selected for synchronization. A single addressable power supply shall be capable of supporting both synchronized and non-synchronized Notification Devices at the same time.

5. The addressable power supply shall operate on 120 or 240 VAC, 50/60 Hz.
6. The interface to the power supply from the Fire Alarm Control Panel (FACP) shall be via the Signaling Line Circuit (SLC) or other multiplexed means. Power supplies that do not use an intelligent interface are not suitable substitutes. The required wiring from the FACP to the addressable power supply shall be a single unshielded twisted pair wire.

7. The addressable power supply shall supervise for battery charging failure, AC power loss, power brownout, battery failure, NAC loss, and optional ground fault detection. In the event of a trouble condition, the addressable power supply shall report the incident and the applicable address to the FACP via the SLC.

8. The addressable power supply shall have an AC Power Loss Delay option. If this option is utilized and the addressable power supply experiences an AC power loss, reporting of the incident to the FACP will be delayed. A delay time of eight or sixteen hours shall be Dip-switch selected.

9. The addressable power supply shall have an option for Canadian Trouble Reporting and this option shall be Dip-switch selectable.

10. The addressable power supply mounts in either the FACP backbox or its own dedicated surface mounted backbox with cover.

11. Each of the power supply's four output circuits shall be DIP-switch selected for Notification Appliance Circuit or General Purpose 24 VDC power. Any output circuit shall be able to provide up to 2.5 amps of 24 VDC power.

12. The addressable power supply’s output circuits shall be individually supervised when they are selected to be either a Notification Appliance Circuit when wired Class "A" or by the use of an end-of-line resistor. When the power supply’s output circuit is selected as General 24VDC power, the circuit shall be individually supervised when an end-of-line relay is used.

13. When selected for Notification Appliance Circuits, the output circuits shall be individually DIP-switch selectable for Steady, March Time, Dual Stage or Temporal.

14. When selected as a Notification Appliance Circuit, the output circuits of the addressable power supply shall have the option to be coded by the use of a universal zone coder.

15. The addressable power supply shall interface and synchronize with other power supplies of the same type. The required wiring to interface multiple addressable power supplies shall be a single unshielded, twisted pair wire.

16. An individual or multiple interfaced addressable power supplies shall have the option to use an external charger for battery charging. Interfaced power supplies shall have the option to share backup battery power.

Field Charging Power Supply: The FCPS is a device designed for use as either a remote 24 volt power supply or to power Notification Appliances and provide synchronization signals to visual strobe devices.
1. The FCPS shall be available in two models offering either up to 6.0 amps (4.0 amps continuous) or 8.0 amps (6.0 amps continuous) of regulated 24-volt power. It shall include an integral charger designed to charge 7.0 amp hour batteries and to support 60-hour standby.

2. The Field Charging Power Supply shall have two input triggers. The input trigger shall be a Notification Appliance Circuit (from the fire alarm control panel) or a relay. Four outputs (two Style Y or Z and two style Y) shall be available for connection to the Notification devices.

3. The FCPS shall include an attractive surface mount backbox.

4. The Field Charging Power Supply shall include the ability to delay the AC fail delay per NFPA requirements.

5. The FCPS include power limited circuitry, per 1995 UL standards.

**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.

**Field Programming**

1. The system shall be programmable, configurable and expandable in the field 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.

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.

5. The system programming shall be "backed" up on a 3.5" floppy diskette utilizing an upload/download program. This system back-up disk shall be completed and given in duplicate.
to the building owner and/or operator upon completion of the final inspection. The program that performs this function shall be "non-proprietary", in that, it shall be possible to forward it to the building owner/operator upon his or her request.

The installer's field programming and hardware shall be functionally tested on a computer against known parameters/norms which are established by the FACP manufacturer. A software program shall test Input-to-Output correlations, device Type ID associations, point associations, time equations, etc. This test shall be performed on an IBM-compatible PC with a verification software package. A report shall be generated of the test results and two copies turned in to the engineer(s) on record.

It shall be the responsibility of the equipment supplier /installer to ensure that all equipment supplied will fit in locations designated on plans and in the specifications.

Specific System Operations

1. Smoke Detector Sensitivity Adjust: 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 be independently selected and enabled 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 anytime 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.

**Network Repeater Panel**

A NRP shall be provided to display all system intelligent points. The NRP shall be capable of displaying all information for all 200,000 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 NRP shall include a minimum of 6 inch or 640 characters, backlit by a long life, solid state LCD display. It shall also include a full QWERTY style keypad with tactile feel. 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 NRP 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 NRP 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 NRP 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 NRP 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 NRP 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 NRP database, upload/download an NRP database, and download an upgrade to the NRP 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 NRP shall include a time of day clock.

Each NCA 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 NRP.

**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 minimum up to 127 intelligent detectors, 127 intelligent modules (monitor or control) of 256 devices. The addition of the optional second loop shall double the device capacity, supporting a total of 600 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, prealarm, 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.
SYSTEM COMPONENTS - ADDRESSABLE DEVICES

Addressable Devices - General

Addressable devices shall use simple to install and maintain decade, decimal address switches. Devices shall be capable of being set to an address in a range of 001 to 159. However, electronic addressing will be accepted only if all the devices can be fully programmed for sensitivity settings, pre-alarm level, etc., from the panel with no extra programming tools and computer shall be used.

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

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

Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.

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.

Intelligent Multi-Co-Operative 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 Co-Operative Sensing, on command from the control panel, send data to the panel representing the analog level of smoke density.

Intelligent Multi Criteria Acclimating Detector

1. The intelligent multi criteria Acclimate detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine it's environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.

2. The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).

3. The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

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 insure 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.

5. The isolator module shall not consume any detector or device address from the loop capacity.

**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.

The Unit shall be UL / FM approved.

**3. CCTV**

**3.1.1 INDOOR DOME CAMERA:**
Indoor Dome Day/ Night Camera with 1/3-Inch EXview HAD CCD II, 650TVL, VF lens 2.8 - 10.5 mm, IR cut filter, min. sensitivity 0.1 lux (colour), 0.04 lux (mono), True Day/Night, Image stabilization, motion detection, digital noise reduction, privacy zones, Connectors, Camera Mounts, Power Supply, Junction box & all required accessories as per detailed technical specification and should be UL/CE listed.

3.1.2 DIGITAL VIDEO RECORDER:
Rack Mountable Stand Alone DVR with 16 ch. Video i/p with min. 4TB HDD internal, 30 days recording, 4 audio i/p, 2 audio o/p, 16 alarm i/p, 4 alarm o/p, all cameras 4CIF recording & view, VGA monitor o/p, 1Gigabit RJ-45 network port, along with suitable client software as per tender technical specifications and should be UL/CE listed.

3.1.3 PTZ CAMERA:
Outdoor 23X PTZ Dome Day/Night Cameras with 1/4” CCD sensor, 540TVL, 23X optical and 12X digital zoom, Continuous 360 deg. Pan, 90 deg. tilt, min 64 Presets, min. sensitivity 0.1 lux (colour), 0.2 lux (B-W), White Balance, Built-in Surge Protection including integrated Dome Housing, Connectors, Camera Mounts, Power Supply & all required accessories as per detailed technical specification and should be UL listed. Joystick with keypad, weather proof box etc as complete as required.
4.0 SOLAR PV SYSTEM WORKS

It is proposed to set up a 33KWP off-grid based system with the objective of renewable power generation and supplying clean electricity to meet the power requirement of the commercial building. The proposed project includes 33KWP system with grid connected.

This is a 33KWP solar Roof mounted off-grid project, connected to the internal grid of the beneficiary organization, which is located in Noida, Uttar Pradesh. Few of the important technical details for the system is as mentioned below:

- **Solar radiation:** 4.70 kWh m² day
- **Latitude & Longitude:** 28°36'56.6" N & 77°21'45.3" E.
- **Total Roof Area Required:** 350sq.m.

The main objective of setting up the SPV power plant is to meet the energy needs of the building partially through solar and thereby demonstrating that solar is capable of supplying reliable clean energy and support electrical demand in the country, which is blessed with more than 300 days of sunshine. The solar power plant shall operate on the principle of direct conversion of sunlight to electrical energy by employing photovoltaic technology.

We will ensure that the installation of the proposed power plant and related infrastructure will meet acceptable standards. The power plant will be scheduled for commissioning within project approval date by MNRE and handing over of land required space by the customer.

**PROJECT DESIGN SUMMARY**

The capacity of the Proposed Solar Power Plant has been decided as 33KWP, the principle factors considered for designing and selection of proposed plant are local solar radiations, ambient conditions, and electrical load characteristics of major system. The detailed structure and specifications of the components are given below.

This section outlines the preliminary solar photovoltaic system design and components for the 33KWP solar photovoltaic power project.

**Solar Photovoltaic (PV) Modules**

Electrical design for the photovoltaic system will be based on a total 100 modules of 250 Wp for 33KWP Approved Technology, framed modules which is equivalent to 33KWP DC installed power. Initial estimate for modules is based on installed capacity, during detail design of the system exact number of PV modules with reference to selection of highest capacity of module and specification, for solar power plant will be estimated.

The modules should comply with the following:

- Certificate with respect to IEC 61215 for design qualification
- Protected by harsh weather conditions by means of a glass pane
- Torsion and corrosion resistant aluminum frames guarantees a long service life and durability
- 10 years guarantee at 90 % and 15 year guarantee on 80% of the initial module rated power
The modules will be framed, giving more rigidity to the module and allows for easier attachment to mounting systems.

The series wiring of modules forming PV strings will be designed to optimize the array's energy production. Outdoor wiring that is exposed to the sun will have UV stabilizer material and is designed to withstand the weather conditions. Cables should be designed for solar applications.

Solar Inverter

It is propose efficient off grid string inverter & suitable number of inverters will be required to take care of 33kWp capacity solar power system to feed in the internal grid of the consumer. Inverters will be designed to produce high-efficiency energy with minimum maintenance requirements & highly reliable & unattended operation. The inverters will comply with international testing certifications and approvals. Higher capacity inverters can also be chosen with reference to site conditions & technical specification provided by consultant.

Deploying string inverters is an ideal choice for roof top mounted photovoltaic systems since they can be easily mounted outdoors withstanding a high ambient temperature of 55 ºC or indoor inside a control room, reduce the need for additional electrical equipment.

The inverters will have all the necessary protection means that meet international electricity regulations such as anti-islanding, over current protection, over voltage protection, short current protection, earth leakage protection & DC disconnects and AC circuit breakers.

Inverters will be equipped with a grid monitoring safety function, which is permanently activated after the inverters have been connected. This function continuously monitors if the effective value of the grid voltage exceeds or falls below the set parameters limit values. In addition, the grid frequency is monitored in terms of the set parameter limit values during operation. The inverters will synchronize their voltage and frequency outputs with that of the grid parameters. If the value exceeds or fall below the limits, the line contactor and the inverter bridge are immediately disconnected. The inverter changes to the failure-operating mode and the grid failure is signalized. The inverter will not restart until the grid voltage is within the permitted limits. This feature makes certain that the inverters remain turned off during maintenance at the grid in order to ensure the safety of the personnel.

Maximum wattage and number of strings of module can be decided after final design of system. The PV strings will be distributed to the closest inverters in a way that ensures minimum cable losses.

The finalized selection of the inverters will be chosen upon award of contract

Solar Mounting Structures

It is proposes the design and supply of Fixed Type Structures for photovoltaic module mounting solution based on initial roof top layout & visit to site. It is proposes fixed type mounting system for roof and will be designed to achieve an optimized tilt angle which gives maximum output. The mounting system components will all be galvanized steel and fasteners from stainless steel.
Contractors should be able to optimize the Fixed Structure to reduce cost after award of the project. Once contract gets finalized, Contractor would be glad to send a more detailed specification of Mounting Structure system for this project.

**AC & DC Cable**

All cables are of copper and of 1000V 1.1 KV grade. The size of cables wires will be designed considering the line loses, maximum load on line, keeping voltage drop within permissible limit and other related factors. The cable wire is of ISI ISO mark for overhead distribution as per the existing norms of MNRE. The size & rating of the cables may vary depending on the site condition, design & capacity of SPV Power Plant.

For normal configuration the suggested are as follows:

- Module to module SJB AJB - 6 sq mm (single core)
- DCDB to PCU - minimum 25 sq mm (single core), or as per design & rating
- PCU to ACDB – as per the final design and rating

**Array Junction Box**

The junction boxes shall be dust and water proof and made of thermoplastic the terminals will be connected to copper lugs or bus-bar of proper sizes. The junction boxes will have suitable cable entry points fitted with the cables. Each main junction box shall be fitted with appropriate rating reverse blocking diode.

**Earthing Kits & Lighting Protection**

The earthing of all outdoor equipment and provision of associated earthing systems, electrodes and connections shall be in accordance with the recommendations in the latest IEEE 80 IS 3043. The grounding design calculation shall conform to ANSI IEEE Standard 80-2000. Earth electrodes shall be provided throughout the plant areas along with the main earth grid. The number of earth electrodes shall be according to achieve the total earth grid resistance less than one (1) ohm. Earth electrodes shall be provided in earth pits. Earth electrodes shall be of heavy duty GI pipes.

Suitable nos. of lighting arrestors shall be provided in the array field. It is installed to protect the array field, all machines and control panels installed in the control rooms. Each LA will be earthed through suitable size earth bus with earth pits.

**AC and DC Distribution Boards**

ACDB consist of box of suitable powder coated metal casting. One feeder will be provided in ACDB with MCB of suitable capacity installed at feeder in the ACDB. Proper rating MCB shall be installed to protect feeders from short circuit current as per the requirements of the site. A separate change over switch of proper rating will also be suitably installed in the ACD to isolate the existing connected load from solar system and cater the power to the existing load from the conventional power (grid) in case of emergency. ACDB should be connected between PCU and load.
5.0 BUILDING MANAGEMENT SYSTEM

Technical Specifications for BMS works

1. Scope of works:

   a) The general character and the scope of work to be carried out under this contract is illustrated in the Data Point Summary, specifications and the schedule of the 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/consultants. The contractor shall furnish all labor, materials and equipment as listed under the schedule of quantities and specified otherwise, transportation and incidentals necessary for supply, installation, testing and commissioning of the complete BAS system as described in the specifications. This also includes any material, equipment, appliances and incidental work not specifically mentioned herein or noted on the documents as being furnished or installed. But which are necessary and customary to be performed under this contract and which are required under the Bill of Quantities and the specifications for the central Integrated Building Automation System.

2. Associated Civil Works:

i. All civil works associated with IBMS installations like making openings to run the conduits and making them good and any other as required shall be covered under the scope of this contract.

3. Project Execution and management:

   The contractor shall ensure that senior planning and execution personnel from his organization are assigned exclusively for this project. They shall have minimum 10 years experience in this type of installations.

   For quality control & monitoring of workmanship, contractor shall assign at least one full time engineer who would be exclusively responsible for ensuring strict quality control, adherence to the specifications and ensuring top class workmanship for the air-conditioning installation.

   The contractor shall arrange to have mechanized and modern facilities for transportation of materials to the place of installation for speedy execution of work.

4. Performance Guarantee:

   The Contractor shall carry out the works in accordance with the specifications, schedule of the quantities and other documents forming part of the contract. The contractor shall be fully responsible for the performance of selected items/equipment (installed by him) at the specified parameters and for the efficiency of the installations to deliver the required end results. The contractor shall guarantee that the IBMS system as installed shall maintain the parameters required under the BOQ and specifications. The guarantee shall be submitted in the Performa sheet. Complete set of architectural drawings are available in the office of architect/consultants and reference may be made to same for any detail or information. The contractor shall also guarantee that the performance of various equipment individually, shall not be less than the quoted capacity.
5. **Bye-Laws and Regulations:**

The installations shall be in conformity with the by-laws and regulations and standards of the local authorities concerned, in so far as these become applicable to the installations. But if these specifications and drawings call for a higher standard of material and/or workmanship than those required by any of the above regulations and standards then these drawings and specifications shall take precedence over the said regulations and standards. However if the specifications require something which violates the bye-laws and regulations, then the bye-laws and regulations shall govern the requirement of the installations.

6. **Fees and permits:**

The contractor shall obtain all permits/licenses and pay for any or all fees required for inspection, approvals and commissioning of their installations if required.

7. **Technical Data:**

Each tenderer shall submit along with his tender, the technical data for all items. Failure to submit complete data with the tenders may result in summary rejection of the tender.

8. **Shop Drawings:**

1.1 All the shop drawings shall be prepared on computer through Autocad system based on the architectural drawings, site measurements and interior designers’ drawings. These shop drawings shall contain all information required to complete terminations. These shop drawings shall contain all the information required to complete the project as per specifications and as required by the Architect/Consultant/Owners site representative. These drawings shall contain details of constructions, size arrangement, operating clearances, performance characteristics and capacity of all items of equipment. Each shop drawing shall contain tabulation of all measurable items of equipment/material/works and progressive cumulative totals from other related drawings to arrive at a variation in quantity statement at the completion of all shop drawings. Minimum 7 sets of drawings shall be submitted after final approval along with their floppies.

Each item of equipment/material proposed shall be a standard catalogue product of an established manufacturer strictly from the manufactures listed in under the approved list of makes and quoted by tenderer in technical data part of tender.

When the Architect/Consultant makes any amendment in the above drawings, the contractor shall supply two fresh sets of drawings with the amendments duly incorporated along with check prints for approval. The contractor shall submit further 7 sets of the shop drawings.

When the Architect/Consultant makes any amendments in the above drawings, the contractor shall supply two fresh sets of drawings with amendments duly incorporated along with check prints for approval. The contractor shall submit further seven copies of shop drawings to the owner's site representative for the exclusive use of the owner’s site representative and all other agencies. No material or equipment may be delivered or installed at the job site until the contractor has in his possession the approved shop drawing for the particular material/equipment/installations.

1.2 Shop drawings shall be submitted for approval four weeks in advance of planned delivery and installation of any material to allow Architect/Consultant ample time for scrutiny. No claims for extension of time shall be entertained because of any delay in works due to his
failure to produce shop drawings at the right time in accordance with the approved program.

1.3 Manufacturers 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 the material/equipment is to be used, giving reference to the governing section and clause number and clearly identifying in ink the items and the operating characteristics. Data for general nature shall not be accepted.

1.4 Samples of all materials like sensors, field devices, controls, control wires etc. shall be submitted to the owners site representative prior to procurement. These will be submitted in 2 sets of approval and retention by owners’ site representative and shall be kept in their site office for reference and verification till the completion of the project. Wherever directed a mockup or sample installation shall be carried out for approval before proceeding for further installations.

1.5 Approval of shop drawings shall not be considered as a guarantee of measurement or that of a building dimension. Where drawings are approved said approval doesn’t mean that the drawings supercede the contract requirements, nor does it in any way relieve the contractor of the responsibility or requirements to furnish material and perform as required by the contract.

1.6 Where contractor propose to use an item or equipment other than that specified or detailed on the drawing which requires any redesign of the structure, partitions, foundations, piping or any other apart of the electrical and architectural layouts, all such redesign and all new drawings and detailing required therefore shall be prepared by the contractor at his own expenses and gotten approved by the architect/consultant/owners site representative. Any delay on such account shall be at the cost and consequences to the contractor.

1.7 IBMS contractor shall prepare coordinated service shop drawings based on the drawings prepared by HVAC, electrical, plumbing & low voltage contractors to ensure adequate clearances are available for installation of service for each trade. Where the work of the contractor has to be installed in close proximity to or will interfere with the work of other trade he shall assist in working out space conditions to make a satisfactory adjustment. If so directed by the owner’s site representative, the contractor shall prepare composite working drawings and sections at a suitable scale, not less than 1:50, clearly showing how his work is to be installed in relation to work of the other trades. If the contractor installs his works before coordinating with other trades or so to cause any interference with work of other trades he shall make all necessary changes without extra cost to the owner.

1.8 Within four weeks of the approval of the relevant shop drawings the contractor shall submit four copies of a comprehensive variation in quantity statement and itemized price list of recommended (by manufacturer) imported and local spare parts and tools covering all the materials/equipment in the contract. The project manager shall make recommendation to owner for acceptance of anticipated variation in contract amounts and also advise Owner to initiate action for procurement of spare parts and tools at the completion of project.

9. **Quite Operation and Vibration Isolation:**

   All equipment shall operate under all conditions of load without any sound and vibration which is objectionable in the opinion of the owner’s site representative.
In case of rotating machinery sound or vibration noticeable outside the room in which it is installed or annoyingly noticeable inside its own room shall be considered objectionable. Such condition shall be corrected by the contractor at his own expenses. The contractor shall guarantee that the equipment installed shall maintain the specified NC levels.

10. Accessibility:

The contractor shall verify the sufficiency of the size of the shaft openings, clearances in cavity walls and suspended ceiling for proper installation of his work. His failure to communicate is insufficiency of the same. The contractor shall locate all equipment which must be serviced, operated or maintained in fully accessible positions.

11. Materials and equipment:

All materials and equipment shall conform to the relevant Indian standards and shall be of the approved make and design. Makes shall be strictly in conformity with the list of approved manufactures.

12. Manufactures Instructions:

Where manufacturer has furnished specific instructions relating to the material/equipment used in this project, covering points especially not mentioned in these documents, such instructions shall be followed in all cases.

13. COMPLETION CERTIFICATE:

On completion of the installation for IBMS a certificate shall be furnished by the contractor, counter signed by the licensed supervisor, under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local authority if applicable.

14. TESTING AND COMMISSIONING

Four copies of the certified manufacturers performance certificates for each piece of equipment, highlighting operational parameters for the project, shall be submitted along with the test certificates. Contractors shall also provide four copies of record of all safety and automatic control settings for entire installation.

The installation shall be tested again after removal of defects and shall be commissioned only after approval by the owners’ site representative. All tests shall be carried out in presence of the representatives of the architect/consultant and owner’s site representative.

15. COMPLETION DRAWINGS

Contractor shall periodically submit completion drawings as and when work in all respects is completed in a particular area. These drawings shall be submitted in the form of two sets of floppy/CD’s and four portfolios (300 x 450 mm) each containing complete set of drawings on approved scale indicating the work as installed. These drawings shall clearly indicate complete plant room layouts, location of wiring and sequencing of automatic controls, locations of all concealed piping, valves, controls, dampers, wiring and other services. Each portfolio shall also contain consolidated control diagrams and technical literature on all controls. The contractor shall frame under glass, in the IBMS room, one set of these consolidated control diagrams.

16. Operating Instructions & Maintenance Manual:
Upon completion and commissioning of part IBMS system the contractor shall submit a draft copy of operating instructions, maintenance schedules and log sheets for all system and equipment included in this contract. This shall be supplementary to manufacturers operating and maintenance manual. Upon approval of the draft the contractor shall submit four complete bound set of typewritten operating instructions and maintenance manuals. One each for retention by consultant and the clients’ representative and two for owners’ operating personnel. These manuals shall also include basis of design, detailed technical data for each piece of equipment as installed, spare parts manual and recommended spares for 3 years period of maintenance of each equipment.

17. On Site Training:
Upon completion of all works and all tests, the contractor shall furnish necessary operator's labor and helpers for operating the entire installation for a period not less than two weeks of ten hours each to enable the owners’ staff get acquainted with the operation of the system. During this period the contractor shall train the owners personnel in the operation, adjustment and maintenance of all equipment installed.

18. Maintenance during defects Liability Period:
18.1 Complains:
The contractor shall receive calls for any or all problems experienced in the operation of the system under this contract, attend to these within four hours of receiving the complaints and shall take steps to immediately correct any deficiencies that may exist.

18.2 Repairs:
All equipment that requires repairing shall be immediately serviced and repaired. Since the period of mechanical maintenance runs for two years concurrently with the defects liability period, all replacement parts and labor shall be supplied promptly free of charge to the owner.

19. Uptime Guarantee:
The contractor shall guarantee for the installed system an uptime of 98%. In case of shortfall in any month during the defects liability period, the defects liability period gets extended by a month for every month having shortfall. In case of shortfall beyond the defects liability period the contract shall get extended by a month for every month having the shortfall and no reimbursement shall be done for the extended period.

The contractor shall provide log in the form of diskettes and bound printed comprehensive log book containing tables for daily record of all temperature, pressure, humidity, power consumption starting and stopping times for various equipment, daily service rendered for the system alarms, maintenance records of unusual observations etc.

Contractor shall also submit preventive maintenance schedule.

Each tenderer shall submit along with the tender, a detailed operation assistance proposal for the owners’ site representative / consultant’s review. This should include the type of service planned to be offered during the defects liability period and beyond. The operation assistance proposal shall give the details of the proposed monthly reports to the management.
The tenderer shall include a list of such project where such operation assistance has been provided.

20. Manpower:
   i) Adequate number of persons to the satisfaction of the owner's site representative shall be provided including relievers.
   ii) Statutory requirements of EPF, ESIC and other applicable labor legislations to be complied with: and monthly certificate to that effect be submitted.
   iii) Duty allocation and roaster control shall be contractor's responsibility.
   iv) No overtime shall be paid by the owner for reasons whatsoever.

SPECIFICATIONS

1. Section 2:

1.0 SYSTEM DESCRIPTION & INPUT OUTPUT SUMMARY

The system will consist of a flat, open architecture that utilizes the LonTalk protocol as the common communication protocol between all controlled and controlling devices, and LNS architecture for the definition of the device database. No other device database structure will be permitted. When necessary or desired, LonTalk packets shall be encapsulated into TCP/IP messages to take advantage of existing infrastructure or to increase network bandwidth. Any such encapsulation of the LonTalk protocol into IP datagram’s shall conform to existing LonMark guidelines for such encapsulation. Systems that utilize non standard routing methods or hierarchal systems consisting of master or global controllers that poll and/or control less intelligent unitary controllers on a secondary bus will not be considered.

Microprocessor based Direct Digital Distributed Controllers (DDC) shall interface with sensors, actuators and environmental control systems (i.e. HVAC, electrical, Fire & plumbing and electrical system etc.) and carry out followings functions:

a. Individual input/output point scanning, processing and control.

b. Centralized operation of the plant (remote control).

c. Dynamic graphic details of plant and building.

d. Energy Management through optimization of all connected electrical and mechanical plants.

e. Alarm Detection and early recognition of faults.

f. Time, event and holiday scheduling as well as temporary scheduling.

g. Prevention of unauthorized or unwanted access.

h. Communication interface and control.
The control system shall be designed such that mechanical equipment will be able to operate under stand-alone control. In general, the operation of any controllers on the network shall not rely on any other controller for its functional operation. System controllers that require a master computer will not be considered. Function specific modules may be used to supplement the functionality resident in each controller. As such, in the event of a network communication failure or the loss of any other controller on the LON, the control system shall continue to independently operate under local control of the resident program stored in nonvolatile memory as detailed herein. In such a case, each individual controller shall continue to perform basic functions until a network connection can be restored.

Each stand-alone intelligent outstation shall control a maximum of One AHU and shall be located adjacent to the Units.

The number of controllers for central plant room equipments shall be decided by the contractor with a maximum capacity limited to 18 points per controller. Overall, the system shall be provided with 15% spare capacity, with spare of at least 15% points on each controller. Also, in case of HVAC system, each controller shall control maximum one chiller and associated chilled water pump.

There shall be one control station located in Building Automation Room. The computer shall be sized to cover the graphic display memory and planning information. The display shall be in the form of dynamic colour graphics and text format with menu driven pop-up windows and help facility.

Reference Standards

1. Control system components shall be new and in conformance with the following applicable standards for products specified:
   i. ANSI\EIA 709.1 (LonTalk Protocol)
   ii. LonMark Certified (Version 3.1 Guidelines)
   iii. UL 916 (Energy Management Equipment)

Products

1. Utilize standard components for all assemblies. Custom hardware, operating system, and utility software are not acceptable.

2. All products (PCU’s, TDCU’s and ID’s) shall contain LonWorks networking elements to allow ease of integration of devices from multiple vendors.

3. All materials, equipment and software shall be standard components, regularly manufactured for this and other systems and custom designed for this project. All systems and components shall be thoroughly tested.

2.0 CENTRAL STATIONS HARDWARE
The Control stations shall comprise of Personal computers (PC) providing high-level operator interface with the system. The terminals shall be capable of providing the operator with the facility for remote system interrogation, control, and retrieval / storage of logged data, annunciation of alarms and reports, analysis of recorded data and the formatting of management reports.

The control station shall consist of the following hardware with all of them suitable for the power supply voltage of 230 V AC ± 10%, 50 Hz ± 3%.

a. Minimum Specifications for Workstations

<table>
<thead>
<tr>
<th>FEATURES</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor</td>
<td>Intel Pentium IV 2.4 Ghz</td>
</tr>
<tr>
<td>Memory</td>
<td>512 MB, DDR 333 Mhz expandable to 2 GB</td>
</tr>
<tr>
<td>Cache (External)</td>
<td>512 KB Pipeline burst cache</td>
</tr>
<tr>
<td>ROM</td>
<td>256 Flash ROM, Can be upgraded from a diskette</td>
</tr>
<tr>
<td>Expansion Bus</td>
<td>3 PCI Slots, 4 ISA slots (3 slot shared)</td>
</tr>
<tr>
<td>Graphic Accelerator</td>
<td>ATI RagePro/AGP graphics accelerator, 4 MB SDRAM</td>
</tr>
<tr>
<td>Hard Disk</td>
<td>80 GB E-IDE/100 ATA</td>
</tr>
<tr>
<td>Power Supply</td>
<td>350 W switchable/50 Hz</td>
</tr>
<tr>
<td>Keyboard</td>
<td>104 keys window 98 keyboard, PS/2 Compatible</td>
</tr>
<tr>
<td>Operating System</td>
<td>Supports Windows XP, OS/2 Warp, Windows NT, DOS 6.22</td>
</tr>
<tr>
<td>Software</td>
<td>Office XP/Vista</td>
</tr>
<tr>
<td>Power Management</td>
<td>EPA compliant</td>
</tr>
<tr>
<td>Desktop Manager</td>
<td>Based on SNMP protocol</td>
</tr>
<tr>
<td>Antivirus Software</td>
<td>PC-Cilin or equivalent pre-loaded</td>
</tr>
<tr>
<td>Diagnostic Software</td>
<td>PAQ 95 or equivalent pre-loaded</td>
</tr>
<tr>
<td>Network</td>
<td>100 Mbps Network Interface Card with wake on LAN support</td>
</tr>
</tbody>
</table>
b. Keyboard: The central station shall be complete with detached 101-keys keyboard which includes full upper/lower case ASCII keyset, a numeric pad, dedicated cursor control pad, and a minimum of 10 programmable functional keys.

c. Colour Monitor: The colour monitors shall be with a minimum 21 inch diagonal non-glare screen and minimum Super VGA resolution of 1024 pixels horizontal, 768 lines vertical and minimum 16 base colors. The monitor shall be with tilt and swivel facilities.

d. Mouse: For keyboard less operation, in addition to the enhanced keyboard, a mouse shall also be provided as an alternative user interface for day to day system operation. 2 Nos. mouse pads shall be provided for each mouse.

e. Printers: The contractor shall provide printers as specified for printing alarms, operator transactions and reports.

There shall be two printers with each Control Station. One printer shall be dedicated for alarm printing and the second printer for printing reports, trend log, summary, tantalizer logging, recording alarms and providing system reports etc. Each of these shall be identical and inter-changeable, and shall have the following characteristics:

i) All the printers shall be Dot matrix printers.

ii) 132 column/300 character per second print speed with minimum 24 pin head.

iii) Adjustable line spacing of six or eight lines per inch with compressed mode option and bidirectional printing and logic seeking.

f. The available PCI slots on the PC shall be used only for communication cards and shall not be utilized for mounting protocol converter cards. If protocol converter cards are used, they shall be external to PC and separately powered and backed-up by the UPS supply.

3.0 CENTRAL STATION SOFTWARE

A. Command & Operating Software

1. As a minimum, the menu driven command and operating software shall permit the operator to perform the following tasks with a minimum knowledge of the HVAC Control System provided and basic computing skills.

I. Configure the network.

II. Create control sequences.

III. Graphical interface to systems.

2. Provide additional third party software to permit the operator to manage hard drive files such as access, delete, copy, modify, etc. The package shall be object oriented and permit the user to manage directories upon boot-up. The file management software shall organize directories and sub-directories using files, file folder objects.

3. On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications
and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.

4. Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operator’s access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.

5. System Diagnostics. The system shall automatically monitor the operation of all HVAC control workstations, printers, modems, network connections, and nodes. The failure of these devices shall be annunciated to the operator.

6. Reports and Logs. Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval, and date. Report data shall be archived on the hard disk for historical reporting. Provide the ability for the operator to obtain real time logs of designated lists of objects. Reports and logs shall be stored on the PC hard disk in a format that is readily accessible by other standard software applications including spreadsheets and word processing. Reports and logs shall be readily printed to the system printer. Data shall be able to transferable to other software packages so as to create custom reports.

7. Web Browser Access: The DDC system shall provide total integration of the facility infrastructure systems with user access to all system data, either locally over a secure Intranet within the building or by remote access by a standard Web Browser over the Internet.

B. Graphical Object-Oriented Programming Software

1. The system shall include a graphical object-oriented programming function which shall be used to create all control sequences utilized in LONWORKS® programmable nodes. The graphical object-oriented programming function shall provide programming elements to be connected together to create a logic diagram. The graphical object-oriented programming function shall include elements for mathematical, logical, timing, setpoint, display and input/output functions to create logic diagrams that represent sequences of operation for LPNs.

2. Program elements shall be able to be combined into a custom template that can then be used as a standard function.

3. Program checkout and debug tools shall include display of real-time and/or simulated system variables and inter-object data on the programming screens. The user shall be able to assign fixed or variable values to inputs during the dynamic debugging of the control sequence.

4. The graphical programming tools shall provide the ability to print I/O lists, lists of standard network variables and lists of all parameters to be viewed by the HMI.
5. The programming software shall reside on each POT and OW server for programming and/or configuring each model of LPN on the project. The applications shall be downloaded and executed at the appropriate nodes. The software shall allow for updated applications via the network from the OW.

6. DDC programs are to be provided to meet the control strategies as called for in the sequence of operation sections of these specifications. Each LPN shall have available a full library of DDC algorithms, intrinsic control operators, arithmetic, trigonometric, logic, Proportional Control, Proportional plus Integral (PI), Proportional plus Integral plus Derivative (PID), and relational operators for implementation of control sequences. 2-POSITION, FLOATING, STANDARD I/O AND COUNTER INPUTS, TIME BASED DATA, CURVE FIT FUNCTION, PSYCHOMETRIC FUNCTIONS, INTEGRATION.

7. All DDC setpoints, gains, and time constants associated with DDC programs shall be available to the operator for display and modification via the POT, DDU or OW interface.

C. Library of Applications: A library of control, application, and graphic objects shall be provided to enable the creation of applications and user interface screens. Provide the capability to cut & paste objects and libraries into applications for a node/system. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together, using a built-in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide “real-time” data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface display shall not be acceptable.

D. Provide integral trend-logging presentation in the programming screen.

E. Print capability, with page break reference tags to allow down to 8 ½”x 11” size paper

F. Off-line simulations (step function, continuous run function, simulation of external inputs)

G. Dynamic presentation of logic in on-line state (all intermediate values)

H. Text to logic screens

I. Memory monitoring

J. Power cycle restart function

K. Run-time capability

L. Calculator objects, (basic stuff), including if-then-else, log, ln, exp, and trig functions.
M. Recognize standard network variable type data (nvi) and create network variables to put on the network (nvo)

N. Programming Objects

1. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects, regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification.

2. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.

3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system (step function and run mode, integral trend logging).

4. The system shall support object duplication within the Owner's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

O. Object Libraries

1. A standard library of object function blocks shall be included for development and setup of application logic, user interface displays, system services, and communication networks.

2. The function blocks in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.

3. Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start / stop time object properties based on the previous day's performance.

P. Application Specific Node Configuration software Tools: Provide application specific node configuration software tools that will permit the individual LASN to be configured and commissioned with appropriate parameters. This software will reside on the POT. Functionality shall include:

1. Recognize all Standard Configuration Parameters (SCPTs)
2. Provide capability for setting all Standard Configuration Parameters (SCPTs)
3. Translation capability for user defined configuration parameters
4. Monitoring capability for nvo's from the nodes
5. Ability to set the values for nvi’s to the nodes

Q. Network Management

1. LonMaker for Windows network management software tool shall be used to assign domain, subnet, and node addresses to nodes; configure all routers and repeaters; define network data connections between LONWORKS® device network variables, known as “binding,” and record binding data into node addressing tables, and create a database of all addressing and binding information for all nodes on the network.

2. Network management shall include the following services: browse all network variables on nodes; Attach, Detach, Manage, Add, Remove, and Replace nodes; plus transmission error off-line, on-line reporting.

3. The network management database shall be resident in the operator workstation server, ensuring that anyone with proper user name/password authorization has access to the network management database at all times.

4. The software shall have Client/server capability to allow multiple users ability to manipulate the database simultaneously.

R. Human-Machine Interface - Operator Workstation Software

1. The HMI shall be a Web Server technology to allow multiple client access to an Ethernet connected server. The workstation shall operate also as a stand-alone workstation/server.

2. The software shall enable an operator to interact with various devices including LONWORKS® nodes, recorders, input/output (I/O) systems, intelligent transmitters, and other field devices.

3. It shall provide the following functions:

i. Calendar.

ii. Scheduling.

iii. Trending.

iv. Alarm monitoring and routing

v. Time synchronization.

vi. Time zone handling

vii. Integration of LONWORKS® controller data

viii. Object linking and embedding for process control (OPC) for connectivity to third party OPC compliant software/devices

ix. Color graphic display

x. On-line plots

xi. Use Microsoft NT security

xii. System documentation generation

xiii. Dynamic data exchange (DDE)

xiv. Dispatch of a single time schedule to all programmable nodes

4. System Configuration. At a minimum, the HMI shall permit the operator to perform the following tasks, with proper password access:

I. Create, delete, upload, or modify control strategies.

II. Add/delete objects to the system.

III. Tune control loops through the adjustment of control loop parameters.

IV. Enable or disable systems

V. Generate text file reports to a networked printer.

VI. Select points to be alarmable and define the alarm state.

VII. Configure alarms to be sent to Microsoft windows mail client

VIII. Select points to be trended over a period of time and initiate the recording of values automatically.
IX. Provide different levels of security to every object in the HMI database.

X. Modify and create users with passwords and access levels and also be able to use currently logged on users and passwords.

5. Event Alarm Notification and Actions

i. The HMI software shall provide alarm recognition, storage, routing, management, and analysis.

ii. The HMI software shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up, telephone connection, or wide-area network.

iii. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:
   a. To alarm.
   b. Return to normal.
   c. To fault.

iv. Provide for the creation of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.

v. Provide timed (schedule) routing of alarms by class, object, group, or node.

vi. Provide alarm generation from “runtime” and/or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

vii. Control equipment and network failures shall be treated as alarms and annunciated.

viii. Alarms shall be annunciated in any of the following manners as defined by the user:
   a. Screen message text.
   b. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
      i. Day of week.
      ii. Time of day.
      iii. Recipient.
   c. Pagers via paging services that initiate a page on receipt of email message.

ix. Auto answer (at OWS) and auto dial (from node)

x. Graphic with flashing alarm object(s).

xi. Printed message, routed directly to a dedicated alarm printer.

xii. Audio messages.

xiii. The following shall be recorded by the OWS HMI software for each alarm (at a minimum):
   a. Time and date.
   b. Location (building, floor, zone, office number, etc.).
   c. Equipment (air handler #, accessway, etc.).
   d. Acknowledge time, date, and user who issued acknowledgement.
   e. Number of occurrences

xiv. Alarm actions may be initiated by user defined programmable objects created for that purpose.

xv. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.

xvi. A log of all alarms shall be maintained by the OWS HMI and shall be available for review by the user.

xvii. Attach a graphic screen, text notes, and/or plant status report, to each alarm, as defined by user.
Repeat/nuisance alarms must have feature to be disabled, and a feature for monitoring disabled alarms.

The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. An alarm notification window will supercede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms.

The dedicated alarm window shall provide user selectable colors for each different priority of alarm.

6. Data Collection and Storage Requirements
   i. The OWS HMI shall have the ability to collect data for any property of any object and store this data for future use.
   ii. The data collection shall be performed by objects, resident in the node, and if desired OWS, shall have, at a minimum, the following configurable properties:
      a. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
      b. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
      c. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
      d. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
      e. All log data shall be stored in a database in the OWS HIM and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.
      f. Systems that cannot provide log data in HTML formats at a minimum shall not be acceptable.
      g. The OW shall have the ability to archive its log data either locally (to itself), or remotely to a OWS server. Provide the ability to configure the following archiving properties, at a minimum:
         i. Archive on time of day.
         ii. Archive on user-defined number of data stores in the log (buffer size).
         iii. Archive when log has reached its user-defined capacity of data stores.
         iv. Provide ability to clear logs once archived.

7. Audit Log
   Provide and maintain an Audit Log that tracks all activities performed on the OWS HMI. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally to OWS HMI or to a server. For each log entry, provide the following data:
   i. Time and date.
   ii. User ID.
   iii. Change or activity: i.e., change setpoint, add or delete objects, commands, etc.

8. Database Backup And Storage
i. The OW shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.

ii. Shall have the ability to automatically complete full or partial backups; and have the ability to full or partial restore. Partial is defined as only items that have changed in the database.

iii. Copies of the current database and, at the most recently saved database shall be stored in the OW. The age of the most recently saved database is dependent on the user-defined database save interval.

9. Graphical Real-Time Displays. The HMI, shall at a minimum, support the following graphical features and functions:

i. Graphic screens shall be developed using any drawing package capable of generating and importing a GIF, BMP, DWG, DXF, or JPG file format. In addition to, or in lieu of a graphic background, the HMI shall support the use of scanned pictures.

ii. Graphic screens shall contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML, or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.

iii. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.

iv. Commands to start and stop binary objects shall be done by clicking the selected object and selecting the appropriate command from the pop-up menu. Data entry may be typed or mouse entered.

v. Adjustments to analog objects, such as set points, shall be done by clicking the selected object and entering value or using a graphical slider to adjust the value.

vi. The OWS shall be able to support multiple graphic objects at the same time. If tiled, then each graphical object shall be fully scalable or aspect locked.

vii. Trend Displays (variable versus time) - A trend display shall show the values of points plotted versus time similar to a strip chart recorder. Eight tags shall be trended per trend. The HMI software shall provide real-time and historical trending (for data which had been logged). This may be achieved by either color graphic page display or a Microsoft excel based display.

viii. Real-Time Trends - shall contain real-time data without consuming hard disk space.

ix. Historical Trends Logs - A historical trend log display presents data stored on the computer's hard disk.

x. X-Y Plots (variable versus variable) - An x-y plot shall dynamically represent the real-time or historical relationship one variable plotted against another variable.

xi. Automatic Generation - All trends and plots shall be self-generated and not require any programming by the user.

xii. The HMI software shall provide dialog boxes and menu picks for configuring trends and plots.

xiii. Any analog or binary data may be trended or plotted.

xiv. The software shall store pre-configured presentation of trends to facilitate operator call-up of trend log displays. It shall be possible to call up a trend log with pre-assigned data.

10. Graphics Builder - The HMI software shall provide a graphics builder.

i. Display Documentation - The graphics builder shall provide show, simulate, review, and document animation functions to allow the user to identify, diagnose, change, and document animation points on each display.

ii. A library of vendor-supplied objects will be included. These objects, widgets, and symbols must be continuously scalable. These items shall be editable by the user.

iii. A library of animated graphic objects shall be included.
iv. Animation - The Graphics Builder will animate process graphics with real-time data from field devices.

v. Multi-State Color Animation shall be provided to change a graphic object's color from a palette of colors.

vi. Alarm Color - Color animation for normal, alarm, and alarm acknowledged states for both analog and binary point tags shall be provided. The user shall define the foreground and background colors for each state.

vii. Alarm Blink – Objects and text data shall blink based on alarm state and acknowledged state.

viii. Text and Numeric Animation - The software shall display the numeric value of an analog point, text of a text point, and the descriptors of a binary point. Display Linking - The software shall provide a display linking function. Clicking the object associated with the link changes the display to a new user-defined display.

ix. Pickable/Non-Pickable - The software shall enable active points to be selected with the mouse and accessed. It shall be possible to make a point non-pickable: the dynamic information shall be displayed, but the operator will not be able to access a detail display, change the value, etc. based on security settings of the software.

x. Ability to open external executable files from button click

xi. Ability to open HTML web pages from button click

xii. Ability to view Microsoft Excel files from button click

11. On-Line Help. Provide a context sensitive help system to assist the operator in operation and editing of the system. Help screens shall be available for all applications and shall provide the relevant data for that particular screen.

12. Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data.

i. System security shall be selectable for each operator.

ii. The system administrator shall have the ability to set passwords and security levels for all other operators.

iii. Each operator password shall be able to restrict the operators’ access for viewing and/or changing each system application, full screen editor, and object.

iv. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected.

v. All system security data shall be stored in an encrypted format.

vi. Each object in the HMI database must be able to have a security policy applied to it.

13. System Diagnostics. The system shall automatically monitor the operation of network connections and controllers. The failure of any device shall be annunciated to the operator.

14. DDE Server - The HMI software shall be able to communicate and exchange data with any Third Party DDE compliant application.

15. The same software will act as programming software.

**4.0 DIRECT DIGITAL CONTROLLER**

**4.1 DIRECT DIGITAL CONTROLLER (DDC) HARDWARE REQUIREMENT:**
1. DDC controllers shall be capable of fully “stand-alone” operation i.e. in the event of loss of communication with other DDC’s or Control Station, they shall be able to function on their own. The controllers shall be LonWorks based products.

2. The controllers shall consist of minimum single 16/32-bit microprocessors for reliable throughput, based with EEPROM based operating system (O.S.).

3. The memory available to the controller board as working space for storage of the Operating system software and data files shall be decided on the basis of number of points being controlled by them.

4. The controllers shall be UL listed and conforming to CE (Euro norms).

5. Controllers requiring nickel-cadmium/lithium battery to support the full operation of the RAM, shall have battery back-up upto 12 hours in the event of a localised mains failure. The battery shall not be required to supply power to actuators, valves, dampers etc.

In addition to the above battery reserve a further battery shall be provided to retain the RAM for a minimum of 2 days, after the expiration of the standard battery.

A. low battery alarm shall be provided with each Controller and with an indication at the Control Station.

In case the memory is stored on EEPROM, the battery backup will not be required.

6. The Controllers shall have proportional control, Proportional plus Integral (PI) Control, Proportional plus Integral plus Derivative (PID) Control, Two Position Control and Time Proportioning Control and algorithms etc, all in its memory and all available for use by the user, i.e. all the control modes shall be software selectable at any time and in any combination. The analog output of Proportional Control, PI Control, and PID Control shall continuously be updated and output by the program shall be provided. Between cycles the analog output shall retain its last value. Enhanced integral action in lieu of Derivative function shall not be acceptable.

7. The controllers shall have a resident real time for providing time of day, day of week, date, month and year. These shall be capable of being synchronized with other clocks in the network.

Back-up power shall support the clock. Upon power restoration all clocks shall be automatically synchronized.

8. The microprocessor based DDC's shall be provided with power supply, A/D and D/A converters, memory, and capacity to accommodate a maximum of 18 input/output (I/O) hardware points (with or without an expansion board). DDC’s with a lower capacity of points shall preferably be provided at the locations with relatively less input/output points.

9. If the controllers provided by the contractor have the configurable plug in function cards, then the following minimum specifications shall have to be met:

i) In addition to the basic outstation, a minimum of two slots shall be provided for the insertion of plug-in function cards.
ii) The cards shall provide for analog or digital, input or output, hardwired connections to the installed plant.

iii) The quantity and combination of these cards shall be determined by the requirements of the plant in that location with the concurrence of the Owner/Consultant.

10. The DDC’s shall have 15% spare capacity (digital/analog input/output) to give flexibility for future expansion.

11. All DDC controllers shall be capable of handling voltage, milli-ampere, resistance or open and closed contacts inputs in any mix, if required.

Analog inputs/outputs of the following minimum types shall be supported:

i) 4-20 mA.
ii) 0-1 volts.
iii) 0-10 volts.
iv) 0-5 volts, and
v) 2-10 volts.
vi) Resistance Signals (either PTC or NTC)
    (PT 100, PT 1000, PT 3000, Balco 500, NI 1000)

Digital input/output types to be supported shall be, but not limited to the following:

i) Normally-open contacts.
ii) Normally-closed contacts.

Modulating outputs shall be true proportional outputs and not floating control type.

12. Controller's packaging shall be such that, complete installation and check out of field wiring can be done prior to the installation of electronic boards.

13. All board terminations shall be made via plug-in connectors to facilitate trouble-shooting, repair and replacement. Soldering of connections shall not be permitted.

14. Controllers shall preferably be equipped with diagnostic LED indicators with at least indication for Power up Test OK, and Bus Error. All LED's shall be visible without opening the panel door.

15. It shall be possible for the controllers to accept regulated uninterrupted power supply to maintain full operation of the controller functions (control, logging, monitoring and communications) in the event of a localized mains failure.

16. Controllers requiring fan cooling are not acceptable.
17. There shall be the facility for accessing controller data information locally, via a portable plug-in keypad display which can be common to all controllers and normally removed to prevent unauthorized tampering. Alternatively each controller shall have a keypad and display integral with its casing for local interrogation and adjustment. In either case, access to the system thus provided shall be restricted by passwords in the same way as at the main operator terminal.

18. In case the Portable operator Terminals (POT) are required to programme the controllers, sockets shall be provided for same. Attachment of POT shall not interrupt or disable normal panel operation or bus connection in any way.

19. The controllers shall be housed in vandal proof boxes to protect them from tampering by any unauthorized personnel. All DDC controllers used in plant room spaces and external application shall be housed IP66/IP54 rating enclosures.

20. It shall be possible to add new controllers to the system without taking any part of the system off-line.

4.2 DIRECT DIGITAL CONTROLLERS CAPABILITIES:

1. The Controllers shall have a self analysis feature and shall transmit any malfunction messages to the Control Station. For any failed chip the diagnostic tests, printout shall include identification of each and every chip on the board with the chip number/location and whether the chip “Passed” or “Failed” the diagnostic test. This is a desired requirement as it would facilitate trouble-shooting and ensure the shortest possible down time of any failed controller. Controllers without such safety feature shall be provided with custom software diagnostic resident in the EEPROM. The tenderer shall confirm in writing that all controllers are provided with this diagnostic requirement.

2. Operating system (O.S.) software for controllers shall be EPROM resident.

Controllers shall have resident in its memory and available to the programs, a relevant library of algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences.

3. In the event of failure of communication between the controllers and/or Control Station terminal, alarms, reports and logs shall be stored at the controllers and transmitted to the terminal on restoration of communication.

4. In the event of memory loss of a Controller, or the expiration of back-up power, on start-up of the unit the necessary data-base shall be downloaded automatically and without operator instruction. Controllers requiring a manual intervention for the re-boot of software are not desired.

5. Where information is required to be transmitted between controllers for the sharing of data such as outside air temperature, it shall be possible for global points to be allocated such that information may be transmitted either on change of incremental value or at specific time intervals.

6. Controllers must be able to perform the following energy management functions as a minimum.
a. Time & Event programs
b. Holiday Scheduling
c. Maximum and Distributed power demand
d. Optimum start and stop program
e. Night purge
f. Load reset
g. Zero energy bands
h. Duty cycle
i. Enthalpy analysis and control
j. Run Time Totalization
k. Sequencing and Optimization
l. Exception scheduling

Detailed description of software features and operating sequence of all available energy management software shall be submitted with the tender for evaluation by the Consultant.

7. The DDC Controllers shall have Adaptive Control capability whereby the control software measures response time and adjusts control parameters accordingly to provide optimum control. The software shall allow self-tuning of the variable control loops (all or any of P, P+I, P+I+D) of the AHU’s and chiller system so as to provide the most efficient and optimized controls at different load conditions. The energy management programs shall update their parameters based on past experience and current operating conditions.

8. Alarm Lockout shall be provided to prevent nuisance alarms. On the initial start up of air handler and other mechanical equipment a “timed lockout” period shall be assigned to analog points to allow them to reach a stable condition before activating an alarm comparison logic.

Tenderers shall indicate their proposed system alarm handling capability & features.

9. Run time shall be accumulated based on the status of a digital input point. It shall be possible to total either ON time or OFF time. Run time counts shall be resident in non-volatile memory.

10. It shall be possible to accommodate Holiday and other planned exceptions to the normal time programs. Exception schedules shall be operator programmable up to one year in advance.

11. Distributed power demand program shall be based on a sliding window instantaneous demand trend algorithm. The DDC interfaced to the demand meter shall calculate the demand, forecast the demand trend, compare it to the established demand limits, and initiate load shedding or re-establishment of loads as required. Shedding shall be on a sequential basis with least important loads shed first and restored last.

4.3 SYSTEM INTERFACE UNITS (SIU) / LAN ROUTERS / REPEATERS

A. General

1. Equip each router with a network transceiver on each network port (inbound and outbound) as dictated by the network type (Type 1 - FTT, Type 2 - TP).
2. The network router shall be designed to route messages from a segment, sub-net, or domain in full duplex communication mode.
3. Routers shall utilize LonTalk® protocol transport, network, and session layers to transparently route messages bound for a node address in another sub-net or domain.
4. Routers and repeaters shall be fully programmable and permit a systems integrator to define message traffic, destination, and other network management functions utilizing LonWorks® software tool.
5. The routers and repeaters shall be capable of DIN rail or panel mounting and be equipped with status LED lights for Network traffic and power.
6. Provide a minimum of two Neuron 3120 or 3150 processors for use as the network router communication controller.

B. Ethernet IP Router

1. Equip each router with an Ethernet IP communication on one side and a LonTalk® transceiver Type 1 FTT or Type 2 - TP on the other side.
2. The network router shall be designed to route messages from a segment, sub-net, or domain in full duplex communication mode.
3. On Ethernet IP side, the router shall utilize Ethernet IP protocol transport to route messages.
4. On the LonTalk® side, the routers shall utilize LonTalk® protocol transport, network, and session layers to transparently route messages bound for a node address in another sub-net or domain.
5. Routers shall be fully programmable and permit a systems integrator to define message traffic, destination, and other network management functions utilizing LonWorks® software tool.
6. The routers shall be capable of DIN rail or panel mounting and be equipped with status LED lights for Network traffic and power.

5.0 PORTABLE OPERATORS TERMINAL (POT)

A. General Requirements.

1. The DDUs shall permit the project operating staff to:
   i. Display point values
   ii. Display parameters
   iii. Change time schedule elements
   iv. List and acknowledge alarms
   v. Monitor points in the system
   vi. Command points (manual overrides) of points
   vii. Override input points (put inputs in test)
   viii. Read and check LonWorks variables on the network
   ix. Password protected
   x. Node configuration for Fan Coil and Rooftop Unit TCUs

2. DDU with the following components:
   i. Liquid Crystal Display
   ii. Minimum 4x20 character
   iii. Pushbuttons for scrolling display and enter
   iv. Permanent mount or portable connection.
DATA COMMUNICATION

The communication between controllers shall be via a dedicated communication network as per LonWorks recommended standards. Controller's microprocessor failures shall not cause loss of communication of the remainder of any network. All networks shall support global application programs, without the presence of a host PC.

Each controller shall have equal rights for data transfer and shall report in its predetermined time slot. There shall be no separate device designated as the communication's master. Those systems using dependent controllers shall be pointed out by the contractor and a dual redundant transmission media with automatic switching and reporting in the event of line faults will have to be provided.

The communication network shall be such that:

1) Every DDC must be capable of communicating with all DDC's.

2) Network connected devices with no messages to transmit shall indicate "No failure" message each cycle. Lack of this message after successive retries shall constitute a communication or device failure.

6.0 FIELD DEVICES

6.1 ELECTRIC AND ELECTRONIC CONTROLS RELATED EQUIPMENT

General Requirements
All controls shall be capable of operating in ambient conditions varying between 0-55 deg. C and 90% R.H. non-condensing.

All Control devices shall have a 20 mm conduit knockout. Alternatively, they shall be supplied with adaptors for 20 mm conduit.

Ancillary Items
When items of equipment are installed in the situations listed below, the BAS contractor shall include the following ancillary items:

(i) Weather Protection

All devices required to be weatherproofed are detailed in the Schedule of Quantities. IP ratings for the equipment are mentioned in the respective section.

(ii) Pipework Immersion
Corrosion resisting pockets of a length suitable for the complete active length of the device, screwed ½” (13 mm) or ¾” (20 mm) NPT suitable for the temperature, pressure and medium.

(iii) Duct Mounting (Metal or Builders Work)
Mounting flanges, clamping bushes, couplings, locknuts, gaskets, brackets, sealing glands and any special fittings necessitated by the device.
Additional features

(i) Concealed Adjustment: All two position switching devices shall have concealed adjustment unless detailed otherwise in the Schedule of Quantities.

(ii) Operating Voltage: All two position switching devices shall operate on 230 v a.c and all accessible live parts shall be shrouded. An earth terminal shall be provided.

6.2 TEMPERATURE SENSOR

Temperature sensors for space, pipes and ducts, shall be of the Resistance Temperature detector (RTD) type or thermistor. These shall be two wire type and shall conform to the following specifications:

1) Immersion sensors shall be high accuracy type with a high resistance versus temperature change. The accuracy shall be at least ± 0.33 degrees F and sensitivity of at least 2 ohm/F.

2) Immersion sensors shall be provided with separate stainless steel thermo well. These shall be manufactured from bar stock with hydrostatic pressure rating of at least 10 kgf/cm².

3) The connection to the pipe shall be screwed ¾ inch NPT (M). An aluminum sleeve shall be provided to ensure proper heat transfer from the well to the sensor. Terminations to be provided on the head. Flying leads shall not be acceptable.

4) The sensor housing shall plug into the base so that the same can be easily removed without disturbing the wiring connections.

5) Duct temperature sensors shall be with rigid stem and of averaging type. These shall be suitable for duct installation.

6) Outdoor air temperature sensor shall be provided with a sun shield.

7) The sensors shall not be mounted near any heat source such as windows, electrical appliances etc.

The temperature sensors may be of any of the following types:

1) PT 100, PT 1000, PT 3000
2) NI 100, NI 1000
3) Balco 500.
4) Thermistor
5) NTC1800

6.3 HUMIDITY SENSOR

Space and duct humidity sensors shall be of capacitance type with an effective sensing range of 10% to 90% RH. Accuracy shall be + 3% or better. Duct mounted humidity sensors shall be provided with a sampling chamber. Wall mounted sensors shall be provided with a housing. The sensor housing shall plug into the base so that the same
can be easily removed without disturbing the wiring connections. The sensors shall not be mounted near any heat source such as windows, electrical appliances etc.

6.4 FLOW METER
Water flow meters shall be either ultrasonic type or electromagnetic type. For electromagnetic flow meter, teflon lining with 316 SS electrodes must be provided. The housing shall have IP 55 protection. Vendors shall have to get their design/selection approved by the Consultant, prior to the supply.

The exact ranges to be set shall be determined by the contractor at the time of commissioning. It should be possible to ‘zero’ the flowmeter without any external instruments, with the overall accuracy of atleast ± 1% full scale.

6.5 PRESSURE TRANSMITTER FOR WATER
Pressure transmitters shall be piezo-electric type or diaphragm type. (Bourdon Tube type shall not be acceptable). Output shall be 4-20mA or 0-10V DC and the range as specified in the data sheet depending on the line pressure. Power supply shall be either 24 V AC, 24 V DC or 230 V AC. Connection shall be as per manufacturer’s standards. The pressure detector shall be capable of withstanding a hydraulic test pressure of twice the working pressure. The set point shall fall within 40%-70% of the sensing range and detector shall have sensitivity such that change of 1.5% from the stabilized condition shall cause modulation of the corrective element. The sensor must be pressure compensated for a medium temperature of -10°C to 60°C with ambient ranging between 0°C to 55°C.

6.6 DIFFERENTIAL PRESSURE SWITCH FOR PIPE WORK
These shall be used to measure pressure differential across suction and discharge of pumps. The range shall be as specified in the data sheet. Switch shall be ON with increase in differential. Housing for these shall be weather proof with IP 55 protection. The pressure switch shall be capable of withstanding a hydraulic test pressure of 1.5 times the working pressure. The set point shall fall in 40%-70% of the scale range and shall have differentials adjustable over 10%-30% of the scale range. The switches shall be provided with site adjustable scale and with 2 NO/NC contacts.

6.7 DIFFERENTIAL PRESSURE SWITCH FOR AIR SYSTEMS
These shall be diaphragm operated. Switches shall be supplied with air connections permitting their use as static or differential pressure switches.

The switch shall be of differential pressure type complete with connecting tube and metal bends for connections to the duct. The housing shall be IP 54 rated. The pressure switches shall be available in minimum of 3 ranges suitable for applications like Air flow proving, dirty filter, etc. The set point shall be concealed type. The contact shall be SPDT type with 230 VAC, 1 A rating.

The switch shall be supplied suitable for wall mounting on ducts in any plane. It should be mounted in such a way that the condensation flow out of the sensing tips. Proper adaptor shall be provided for the cables.

The set point shall fall within 40%-70% of the scale range and have differentials adjustable over 10%-30% of the scale range.
The switches shall be provided with site adjustable scale and with 2 NO/NC contacts.

6.8 AIR FLOW SWITCHES
Air flow switches shall be selected for the correct air velocity, duct size and mounting attitude. If any special atmospheric conditions are detailed in the Schedule of Quantity the parts of the switches shall be suitably coated or made to withstand such conditions. These shall be suitable for mounting in any plane. Output shall be 2 NO/NC potential free. Site adjustable scale shall also be provided.

6.9 AIR PRESSURE SENSOR
The pressure sensor shall be differential type. The construction shall be spring loaded diaphragm type. The movement of the membrane in relation to the pressure should be converted by an inductive electromagnet coupling which would give an output suitable for the controller. The pressure sensor shall be in a housing having IP 54 ratings in accordance with IEC 529. Suitable mounting arrangement shall be available on the sensor. The sensor shall come complete with the PVC tubes & probes.

6.10 WATER FLOW SWITCH
These shall be paddle type and suitable for the type of liquid flowing in the line. Output shall be 2NO/2NC potential free.

6.11 TRANSDUCERS FOR ELECTRICAL SERVICES
Electrical transducers shall be integrated electronic type and rack mounted on the field. These shall work on 230 V supply with the output being standard type i.e. 4-20 mA, 0-10 Volts etc.

Power factor, Voltage, Current, Frequency and Kilowatt transducers shall have standard output signal for measurement for the specified variable.

Kilowatt-Hour metering (if any) shall be poly-phase, three-element with current transformer (CT) operated type. The metering shall feature high accuracy with no more than +/- 1% error over the expected load range. The coils shall be totally encapsulated against high impulse levels.

6.12 LEVEL SWITCH
The level switches shall have to meet the following requirement:

<table>
<thead>
<tr>
<th>Type</th>
<th>Float Type/Capacitance type/Conductivity type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mounting</td>
<td>To suit application.</td>
</tr>
<tr>
<td>Connection</td>
<td>Flanged ANSI 150 lbs RF Carbon steel</td>
</tr>
<tr>
<td>Float material</td>
<td>316 SS</td>
</tr>
<tr>
<td>Stem Material</td>
<td>316 SS</td>
</tr>
<tr>
<td>Output</td>
<td>2 NO, 2 NC potential free</td>
</tr>
<tr>
<td>Switch Enclosure</td>
<td>IP 55</td>
</tr>
</tbody>
</table>
6.13 CONTROL VALVES (AIR HANDLING UNITS)

Control valves for the Air Handling Unit’s shall be globe type, two way suitable for Variable flow hydraulic system.

The Manufacturer’s standards shall be applicable for these valves.

Valves

<table>
<thead>
<tr>
<th>Type</th>
<th>Two way mixing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stem / Trim</td>
<td>SS-316 or better</td>
</tr>
<tr>
<td>Plug and seat</td>
<td>SS-316 or better</td>
</tr>
<tr>
<td>Plug characteristics</td>
<td>Equal Percentage</td>
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<tr>
<td>Service</td>
<td>Chilled water</td>
</tr>
<tr>
<td>Stroke Length</td>
<td>Minimum 20 mm</td>
</tr>
<tr>
<td>Compliance</td>
<td>IEC 534</td>
</tr>
<tr>
<td>Packing</td>
<td>Teflon</td>
</tr>
</tbody>
</table>

Actuator

<table>
<thead>
<tr>
<th>Actuator</th>
<th>Electrical/Electronic/Magnetic.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actuator type</td>
<td>Proportionating(Modulating)</td>
</tr>
<tr>
<td>Spring return function</td>
<td>Yes</td>
</tr>
<tr>
<td>Travel limit switch</td>
<td>2 Nos. for open and close.</td>
</tr>
<tr>
<td>Hand wheel</td>
<td>Required</td>
</tr>
<tr>
<td>Input signal</td>
<td>0 – 10 V dc, 4 – 20 mA</td>
</tr>
<tr>
<td>Specification</td>
<td>Requirement</td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td>Power Supply</td>
<td>240 V ac</td>
</tr>
<tr>
<td>Thrust</td>
<td>To be selected by the vendor</td>
</tr>
<tr>
<td>End Connections</td>
<td>Screwed upto 2” Beyond that ANSI 150 Lb RF</td>
</tr>
<tr>
<td>Noise Level</td>
<td>Not exceeding 70 DB</td>
</tr>
<tr>
<td>Weather Proof</td>
<td>NEMAI</td>
</tr>
</tbody>
</table>

Note:
Actuator should be directly coupled to the trim. Eccentric linkages not acceptable.
Leakage not to exceed 0.1\% of flow.

6.14 CONTROL FOR AHU

Control valves for the Air Handling Unit’s shall be globe type, two way suitable for Variable flow hydronic system as indicated in BOQ.

6.14.1 Two way motorized valves

Two way motorized valves shall be provided in chilled water lines at each fan coil units. The valve shall be actuated by space thermostat. Constant space conditions shall be maintained by allowing chilled water through the coil. The valve shall be provided with spring return function so that it revert to fully closed position when fan is shut off. Valve shall be two/three position with flare connections. Valve shall have the facility to replace motor \ actuator without removing the valve body. Actuator shall be suitable for 240 V, 50 Hz ac or 24V ac. Maximum close off pressure shall be selected to suite the CV requirement.

6.14.2 Thermostats

Thermostat shall be snap acting fixed differential type thermostat for air-conditioning application for actuating the two way valve at each fan coil unit with HI-MED-LO fan switch and system setting OFF-FAN-COOL. Switching off must break fan circuit. Thermostat shall be provided with necessary relays to operate valve of cooling coil.

6.15 TWO WAY MOTORIZED BUTTERFLY VALVE

6.15.1 Valve
Type of valve: Butterfly Valve.

Body Material: Carbon steel ASTM A 216

Body seat ring (if applicable): Gr WCB

Vane: SS-316

Packing: Teflon

Mounting Stool: Required

Shaft: SS-316

Seat: Nitrile rubber

Fasteners: SS-316

6.15.2 Actuators

Type: Electric

Duty: On/Off (Maximum 50 operations per day)

Motor power supply: 230 V AC or 415 V 3-phase

Travel limit switches: 2 Nos

Torque limit switches: 2 Nos

Hand wheel: Required

Speed: Approx 150 mm/min

NOTE
a. Actuator must open/ close with one changeover contact. Control panel, if required, must be supplied integral with the Actuator.

b. No gear box is envisaged, however if gear box is provided, the travel limit switches must be connected directly to the valve stem.

c. Cover tube for the valve stem must be provided

7.0 ELECTRONIC METERING
Electronic metering shall be provided on the main LT panel at incoming and outgoing feeders. These meters shall be free supply by the BAS contractor to the Electrical contractor whereby these shall be installed in the LT panel by the Electrical contractor. The electrical contractor shall also provide necessary CT, PT and 220 V power input for the meters. All further control wiring and networking of the meters shall be in scope of BAS contractor.

The specifications for the electronic meters to be supplied by BAS contractor is as follows:

<table>
<thead>
<tr>
<th>Type</th>
<th>Static Power Meter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>1.0 accuracy</td>
</tr>
</tbody>
</table>

Instantaneous Measurements:

a. V (1-n), V (1-1) & 1 per ph & avg. V & I unbalance

b. PF per ph & total, frequency

c. Power & BI-directional energy (active, apparent, reactive)

d. Peak & Predictive Demand (I, W, VA, VAR totals)

e. V & I harmonics (Individual & Total)

f. Time of use (internal calendar, multiple daily tariff, energy & demand accumulators).
**Features**

- a. Event Triggered
- b. Sequence of event
- c. Panel mountable
- d. Internal battery backup
- e. Transducerless connection via standard CT / PT
- f. Y2K compliance

**Display**

- Local LCD display panel user formattable display with scrollable screens.

Software interface shall be ensured by BAS contractor for the electronic meters. Systems requiring transducers for duplicating the data shall not be accepted.

All the instantaneous measurements shall be displayed on the control stations and the data shall be logged. It shall be possible to access minimum / maximum logging of any parameter with alarm annunciation for unusual measurements. The system shall also accept user defined “Set-Point” limit of any parameter.

### 8.0 ENCLOSURES FOR CONTROLLERS AND ELECTRICAL PANELS

All the controllers shall be housed in Lockable Vandal proof boxes which shall either be floor mounted or wall mounted. These shall be free standing, totally enclosed, dust and vermin proof and suitable for tropical climatic conditions.

The panel shall be metal enclosed 14 SWG CRCA sheet steel cubicle with gaskets between all adjacent units and beneath all covers to render the joints dust proof. All doors and covers shall be hinged and latched and shall be folded and braced as necessary to provide a rigid support. Joints of any kind in sheet metal shall be seam welded with welding slag grounded off and welding pits wiped smooth with plumber metal.

All panels and covers shall be properly fitted and secured with the frame and holes in the panels correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with nuts. Self threading screws shall not be used in the construction of control panels. Knockout holes of approved size and number shall be provided in the panels in conformity with the location of incoming and outgoing conduits/cables. Lamps shall be provided to support the weight of the cables. The dimension of the boxes shall depend on the requirement with the colour decided in consultation with the Architect/Consultant.
Note: All panel enclosures used in plant room spaces and external to building shall be suitable for outdoor application (IP 54 protection) and UL listed.

9.0 CONDUITS AND WIRING

Prior to laying and fixing of conduits, the contractor shall carefully examine the drawings indicating the layout, satisfy himself about the sufficiency of number and sizes of conduits, sizes and location of conduits and other relevant details. Any discrepancy found in the drawings shall be brought to the notice of Architect/Engineers. Any modifications suggested by the Contractor shall be got approved by the Architect/Engineers before the actual laying of conduits is commenced.

9.1 CONDUITS / TRUNKER

Conduits and accessories shall conform to relevant Indian Standards. PVC conduits of required dia shall be used as called for in the schedule of quantities. Joints between conduits and accessories shall be securely made, with help of adhesive.

The conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

9.2 CONNECTIONS

All jointing methods shall be subject to the approval of the Architect/Engineer. Separate conduits shall run for all power wiring.

The threads and sockets shall be free from grease and oil. Connections between conduit and controller metal boxes shall be by means of brass hexagon smooth bore bush, fixed inside the box and connected through a coupler to the conduit. The joints in conduits shall be smooth to avoid damage to insulation of conductors while pulling them through the conduits.

9.3 BENDS IN CONDUIT

Where necessary, bends or diversions may be achieved by means of bends and/or circular inspection boxes with adequate and suitable inlet and outlet screwed joints. In case of recessed system each junction box shall be provided with a cover properly secured and flush with a finished wall surface. No bends shall have radius less than 2-1/2 times the outside diameter of the conduit.

10.0 SIGNAL CBLING & COMMUNICATION CBLING

The signal cabling shall be of the following specifications:

- **a. Wire:** Annealed Tinned Copper
- **b. Size:** 1.5 sq. mm, 7 strands
- **c. No. of conductors:** Two (One pair)
- **d. Shielding:** Overall beld foil Aluminium Polyester shield.
- **e. Jacket:** Chrome PVC
- **f. Nominal DCR:** 17.6 ohm/km for conductor 57.0 ohm/km for shield
- **g. Nominal OD:** 8.5 mm
h. Nominal capacitance : 130 pF/m between conductors at 1 KHz 180 pF/m between one conductor and other conductors connected to shield.

i. Colour : Black and Red

10.1 COMMUNICATION CABLE

The communication cable shall be of the following specifications:

a. Wire : Annealed Tinned Copper

b. Size : Minimum 24 AWG stranded

c. No. of conductors : One pair (2 conductor)

d. Shielding : Overall beld foil Aluminium polyester i. Shield.

e. Jacket : Chrome PVC

f. Nominal DCR : 78.7 ohm/km for conductor 55.8 ohm/km for shield

g. Nominal OD : 5.64 mm

h. Nominal capacitance: 131 pF/m between conductors at 1 KHz 243 pF/m between one conductor and other conductors connected to shield.

i. Colour : Black and Red, Black and White)

2. Section 3 :

The VFD shall be of the type suitable for operation on a 3 phase, 415 V, 50 Hz input power supply at the following conditions:

- Input supply voltage variations : ± 10%
- Input supply frequency variations : 48 – 62 Hz ± 1%
- Ambient temperature : 0 - 45°C, without derating.
- Maximum relative humidity : 95% non condensing
Vibration: 0.7 g RMS in 3 directions

Minimum efficiency at full load: 96%

1) The VFDs will be mounted in the open near the AHUs Cooling towers in the AHU room / Plant room. Hence the VFDs shall have integrated, factory built metallic enclosures of IP 54 rating, without any de-rating. VFDs of IP00 / IP 20 / IP 21/ IP 42 rating enclosures with additional sheet metal enclosures to achieve IP 54 ratings are not permitted.

2) VFDs shall conform to the recognized international standards like IEC and manufactured according to ISO 9001, BS 5750 part 1 & 2 and shall be UL listed. It shall carry the CE mark on EMC compliance.

3) The VFD shall be capable of providing a starting torque of 160% for 0.5 sec and an overload torque of 110% torque for 1 minute.

4) The VFD shall maintain full output voltage during main’s variations of ± 10% to prevent loss of torque and speed variations occurring during motor operation.

5) The VFD shall comply with Electro Magnetic Compatibility (EMC) product standard EN61800-3, First Environment, Unrestricted distribution with minimum 50 meters of output cabling. The supplier of drives shall include additional filters needed, if any, to meet this compliance.

6) The VFDs shall allow connecting shielded / screened 3 core plus earth motor cable for all power sizes, without any restriction.

7) The VFDs shall have internal harmonic filters on both limbs of the DC bus to reduce current harmonics. AC line chokes on the input side are not allowed for harmonic current control as it will cause voltage drop to the VFD and motor.

8) For easier maintenance and to reduce inventory, the VFD shall allow connection of motors one frame size larger and 4 sizes smaller than its nominal rating.

9) The VFD shall have the following protective functions: Electronic motor overload, Protection to motor and VFD against input transients, phase loss, short circuit, under voltage, over voltage, phase imbalance, motor over temp., phase to phase short circuit or earth fault at motor terminals.

10) The U_{peak} of the VFD shall be below 1000 Volts (when measured with a cable length of 50 meters) to prevent damage to motor insulation. Manufacturer of the VFD shall submit data sheet to verify this requirement in order to permit the usage of standard motors for the applications specified.

11) The VFD shall be capable of having an output motor cable length of at least 150 meters (armoured cabling) without any need of additional equipment like output chokes. This is essential for applications like chilled water pumps and cooling towers where the motors are located far away from the control center.

12) The VFDs shall incorporate a surge protection circuit as standard to protect the VFD from transients and spikes in the incoming power supply.
13) The VFD shall be fully protected from switching a contactor / isolator at the output without causing tripping e.g.: for switching on/off the isolators of the AHU / ventilation fans / pumps near the motor and switching back ON with VFD in on mode.

14) The VFD shall monitor the belt (AHU etc.) or coupling etc., and it shall display a warning signal if it detects a broken coupling / belt. There shall be provision to export this warning signal to the BMS system through RS 485, without any need of I/Os.

15) The display of the VFD shall be Alpha numeric type. Display of all messages and faults shall be in English text format. Codes are not acceptable. The display shall show the following operating parameters:

- Power consumed by motor in kW
- Run time of motor in Hours
- Current drawn by motor in Amps.
- Output frequency in Hz.
- Motor speed in RPM
- Set point in process units
- Feedback in process units

16) It shall be possible to see at least 4 of the above operating parameters in the VFD display, simultaneously.

17) A parameter lock shall be available in the VFD local display panel to prevent unauthorized resetting of parameters.

18) The VFDs shall have internal galvanic isolation (PELV) to avoid damage to BMS / PLC / DDC system when interconnected. If PELV is not available, the VFD vendor should offer opto-isolators for all the inputs and outputs in the VFD.

19) The VFD shall automatically adjust the switching frequency based on motor current demand rather than motor speed so that the best possible switching frequency is provided, to match both performance and to maintain silent operation all speeds. The switching frequency range shall be from 4-14 kHz for VFDs to be installed on AHUs.

20) The VFD shall monitor the relationship between voltage and current in the motor and adjust the output voltage to minimize current and maximize motor and drive efficiency. VFDs offering fixed settings of V/f ratios are not permitted.

21) The VFD shall have Auto / OFF / Manual switch on the key pad itself. It shall be possible to manually change the speed of the AHUs from the key pad of the VFD, if required, without the need of an external potentiometer. In manual mode the speed reference signal shall be from keypad of VFD and in auto mode, the reference shall be from the remote – either BMS or transmitter.

22) The VFD shall have self adjustable ramp times to prevent tripping / VFD damage in case inappropriate ramp times are set with respect to application requirement.

23) The VFDs shall have the provision to program a minimum and maximum speed of operations, through the VFD programming itself.

24) In case of a power failure, the VFD shall be capable of automatically restarting after a programmable time delay, without the need of an operator having switch on the unit.
25) To prevent damage to the VFDs due to pre-rotating fans, the VFD shall have the capability to detect such spinning fans and adjust its frequency to its spinning speed before it starts controlling the fan. If the fan is running in the opposite direction, the VFD should brake the fan by sending a DC current, before starting the fan in the right direction.

26) If a temperature / pressure / flow feedback signal is given to the VFD, it shall use its PID controller to modulate the speed in such a way that the set point of temperature or pressure is accurately maintained.

27) The VFD shall be capable of accepting two such feedback signals simultaneously and be able to do a speed control based on average / sum / difference / minimum / maximum / 2 zone control of the above 2 signals.

28) The feedback signal shall be monitored by the VFD and should provide a warning signal if the feedback goes above or below the programmed high and low limits. It shall be possible to transfer this signal to the BMS system as well.

29) If the VFD loses the feedback signal or reference signal in auto mode, the VFD shall be capable of maintaining the speed at which it is running or to go to maximum speed or to trip.

30) The VFD shall have the provision to automatically stop the motor when the feedback signal remains at the low level for a predetermined time.

31) The PID controller shall be capable of programming the set points and incoming signals in any of the following units: RPM, l/s, l/m, l/h, m³/h, m³/s, bar, Pa, kPa, GPM, lb/s, lb/h, CFM, in³/h, inwg, ft wg, PSI, kW, HP, °C, °F, as required by the application, and be able to display the same while in operation.

32) The VFD shall enable the motor to step over speeds that cause mechanical vibration / resonance in duct work / pipe lines which can potentially damage the mechanical components in the system.

33) The VFD shall have an auto de-rating facility by operating at a lower capacity in case of a phase loss or higher ambient temperature so that minimum air conditioning can be maintained. VFDs that trip on a phase loss or high ambient temperature are not suitable for this application and hence not permitted.

34) The VFDs shall have the provision of 4 parameter set ups, which can be activated by the IBMS or by digital inputs.

35) The VFD shall have the provision to generate a warning signal, if the operating frequency is above or below programmed the high and low limits, to stage on / off other devices.

36) The variable frequency drives (VFD) shall have the provision to integrate into a BMS system, utilizing a serial communication through Modbus RTU protocol that enables a full “read & write” seamless interface between the VFD & IBMS. The VFD manufacturer shall be responsible for technical support to the IBMS Vendor in the implementation of a serial interface to the BMS System. The BMS Vendor shall be responsible for the complete “integration and interoperability” of the VFD through the IBMS via the serial interface.
The VFD shall provide to IBMS, via serial communication (by RS-485, 2 wire), access to the following VFD parameters as a minimum:

- Motor current
- Motor kW
- AHU KWh
- AHU Running hours
- Auto / Off / Manual status feedback
- PID controller programming
- Set point programming
- Alarms
- Run & Trip status
- Air flow status / alarm
- Dirty filter status / alarm
- Fault log history

The VFD shall also be able to provide the following selectable & programmable physical I/Os to the BMS system:

- Digital inputs (for start, stop, interlock, auto, manual, setup selection etc.)
- 1 Relay outputs (for reading Auto / Manual status & VFD On / Off indication)
- 1 Analog input, 4 – 20 mA (for single feedback signal to VFD)
- Analog inputs 0-10V (for feedbacks, if two feedbacks are taken)
- Analog Outputs, 4-20 mA (for speed & kW feedback to IBMS)

It shall be possible to read the digital / analog inputs and control the analog and relay outputs of the VFD from the BMS system through the serial communications, thereby enabling the drive's inputs / outputs to be used as extended I/Os for the IBMS system, to achieve maximum operational and cost efficiency.

To extent the life of a motor in a damp environment (like cooling towers), the VFD should trickle a small amount of current to the motor, while stopped, to protect it from condensation and the effects of a cold start.

Upon receiving a start command, the VFD should be able to export another signal, which can be used to start a damper / valve motor actuator. On receiving the signal from damper / valve that it is open, the VFD should start its operation. If the valve / damper is closed, the VFD should not start.

The VFD should have a start delay feature, where in it gives time to prepare for the operation, open dampers or VAV boxes before starting to accelerate the motor.

The VFD should have a fireman's override feature, where in the drive can override its standard settings to provide for a life safety application such as building pressurization or smoke purge operation.

The VFDs shall have a Real Time Clock (RTC) by which the start / stop of the system can be programmed on a real time basis along with scheduling. The RTC should also allow
the speed of the VFD to be changed on the basis of actual time and also log the faults with a date and time stamp.

3. **Section 4:**

**VARIABLE AIR VOLUME BOXES (VAV)**

1.0 **SCOPE**

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

1.0 **CODES and STANDARDS**

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

3.0 **CONSTRUCTION FEATURES**

Construction details shall be generally in accordance with the details given here under.

**VARIABLE AIR VOLUME (VAV) BOXES**

a. These shall of the low velocity variable air volume boxes without re-heat coils, and shall be a proprietary line as marketed by a firm specializing in this field. The contractor shall supply and install units to the quantity and locations as specified.

b. The unit shall be complete with damper, airflow ring, and solid-state electronic controls to provide accurate room temperature control. The damper shall be aerofoil type construction with bearings.

c. Boxes shall be supplied with all internal attenuation treatment and acoustical damped casing necessary to achieve the required noise criteria. Casing shall be of 22 G GSS minimum fitted with a completely sealed, easily removable means of access to all internal parts. Access to all boxes must be from the underside only.

d. The actuator shall be of 24V AC Bi-directional, direct coupled to the damper shaft. The required transformer to step down of the voltage range from 230V to 24V shall be part of the unit. The UPS power point with an isolator near the VAV will be provided by other agencies.

e. The unit shall be complete with transformer, access panel and other accessories as per the standard. The noise level shall be less than 35Dba.

f. Maximum allowable static pressure to the boxes for its satisfactory operation shall not exceed 0.10 "W.G. otherwise fan and motor selections may be affected.
g. Boxes shall be able to reset any air flow between 15% and the maximum air quantity that the boxes can handle without changing orifices or other parts. Air quantity limiters will not be accepted.

h. A suitable device shall be provided for the field adjustment of minimum airflow. All boxes shall be initially factory set at minimum air quantity of 15% of the design requirements. Under shut-off conditions, all boxes shall not have air leakage more than 2% of the maximum air quantity at 75mm static pressure.

i. The VAVs shall be used in standalone mode complete with its own temperature sensor and controller and shall perform the function of maintaining the temperature and airflow. However, the VAVs shall be BMS compatible to enable to network the VAVs to a Network Control Unit and onto BMS. In this mode all VAV data shall be available at the BMS workstation and it shall be possible to change set points and flow settings from the BMS workstation. VAVs shall able to release open protocol Lonworks and to integrate with any third party Building Management System.

j. The boxes shall be pressure independent.
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description</th>
<th>Approved Makes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A)</strong> M.V SWITCHGEAR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i)</td>
<td>ACB</td>
<td>SCHNIEDER- (EASY PACT MVS) / L &amp; T (U-POWER)</td>
</tr>
<tr>
<td>ii)</td>
<td>MCCB</td>
<td>SCHNIEDER- CVS / L &amp; T (D-Sine SERIES) / SIEMENS (3VT) / ABB (TMAX).</td>
</tr>
<tr>
<td>iii)</td>
<td>On Load Changeover Switch</td>
<td>L &amp; T / HPL - SOCOMEC</td>
</tr>
<tr>
<td>iv)</td>
<td>MCB/ MPCB/ RCCB/RCBO</td>
<td>LEGRAND / SCHNEIDER / ABB / L&amp;T</td>
</tr>
<tr>
<td>v)</td>
<td>Contactors</td>
<td>L &amp; T / SCHNEIDER / SIEMENS / ABB</td>
</tr>
<tr>
<td>vi)</td>
<td>Capacitor Bank</td>
<td>L &amp; T / SCHNEIDER / SIEMENS / ABB / EPCOS / Ducati</td>
</tr>
<tr>
<td><strong>B)</strong> METERS / INDICATORS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i)</td>
<td>Ammeter / Voltmeter / P.F. Meter / Frequency meter / KW meter / Energy Analyzer (Digital type)</td>
<td>SCHNEIDER / SIEMENS / L &amp; T</td>
</tr>
<tr>
<td>ii)</td>
<td>Indicating Lamps (LED type)</td>
<td>SIEMENS / L &amp; T (ESSBEE)</td>
</tr>
<tr>
<td>iii)</td>
<td>Push Button's</td>
<td>SIEMENS / L &amp; T (ESSBEE)</td>
</tr>
<tr>
<td>iv)</td>
<td>KWH Meter (Digital Type)</td>
<td>L &amp; T / SCHNEIDER / SIEMENS</td>
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<tr>
<td><strong>C)</strong> INSTRUMENT TRANSFORMERS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i)</td>
<td>LT Current Transformers (Resin Cast) 415V</td>
<td>AE / KAPPA / MATRIX / PRECISE</td>
</tr>
<tr>
<td>ii)</td>
<td>HT Current Transformers &amp; Potential Transformers (Resin Cast) 11KV</td>
<td>KAPPA / ECS / PRAGATI</td>
</tr>
<tr>
<td><strong>D)</strong> RELAYS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i)</td>
<td>Surge Arrestor</td>
<td>L &amp; T / PHONIX / ABB / RAYCHEM / CAPE</td>
</tr>
<tr>
<td><strong>F)</strong> CABLES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i)</td>
<td>HT Cables</td>
<td>KEI / POLYCB</td>
</tr>
<tr>
<td>ii)</td>
<td>LT Cables</td>
<td>KEI / POLYCB / RR CABLE / SKYTONE / PARAMOUNT</td>
</tr>
<tr>
<td><strong>G)</strong> WIRING ACCESSORIES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i)</td>
<td>M.S Conduit / GI Conduit (ISI marked)</td>
<td>R-CON (BEC) / RM-CON</td>
</tr>
<tr>
<td>ii)</td>
<td>PVC Conduit (FRLS) (ISI marked)</td>
<td>BEC / POLYPACK / ESC / AKG</td>
</tr>
<tr>
<td>iii)</td>
<td>Wiring Cable, FRLS</td>
<td>FINOLEX / KEI / POLYCB / RR CABLE / SKYLINE / BONTON / ESC</td>
</tr>
<tr>
<td>iv)</td>
<td>Telephone Wiring Cable</td>
<td>DELTON / FINOLEX / KEI / POLYCB / SKYLINE / ESC / PARAMOUNT</td>
</tr>
<tr>
<td>v)</td>
<td>Data Cables / Data Sockets</td>
<td>AWAYA / AMP / LEGRAND</td>
</tr>
<tr>
<td>vi)</td>
<td>Switches &amp; Sockets</td>
<td>CRABTREE, OPALE (SCHNEIDER)/LEGRAND MYRIUS SERIES/ ANCHOR WOODS (PANASONIC) / WIPRO / L&amp;T / ABB / PHILLIPS AS PER SAMPLE APPROVED</td>
</tr>
<tr>
<td>vii)</td>
<td>Metal Clad Sockets / PVC Moulded Sockets (3Phase / 1 Phase)</td>
<td>LEGRAND / SCHNEIDER / HENSEL / BALS</td>
</tr>
<tr>
<td>viii)</td>
<td>MCB/ DB’s (FACTORY FABRICATED)</td>
<td>LEGRAND / SCHNEIDER / ABB / L&amp;T</td>
</tr>
<tr>
<td>ix)</td>
<td>RCCB/RCBO</td>
<td>LEGRAND / SCHNEIDER / ABB / L&amp;T</td>
</tr>
<tr>
<td>H)</td>
<td>MISCELLANEOUS</td>
<td></td>
</tr>
<tr>
<td>i)</td>
<td>Lugs/ Thimbles</td>
<td>COMET / JAINSON / DOWELS</td>
</tr>
<tr>
<td>ii)</td>
<td>Glands</td>
<td>COMET / DOWELS / GRIPWELL</td>
</tr>
<tr>
<td>iii)</td>
<td>Terminal Blocks</td>
<td>CONNECTWELL / ELMEC / WAGO</td>
</tr>
<tr>
<td>iv)</td>
<td>Selector Switch</td>
<td>KAYCEE / SALZER</td>
</tr>
<tr>
<td>v)</td>
<td>11KV Termination kits</td>
<td>RAYCHEM / 3M / DENSON</td>
</tr>
<tr>
<td>I)</td>
<td>ADDRESSABLE FIRE ALARM &amp; PUBLIC ADDRESSABLE SYSTEM</td>
<td>NOTIFIER HONEYWELL / BOSCH / EDWARD</td>
</tr>
<tr>
<td>J)</td>
<td>CABLE TRAY (GI SHEET / POWDER COATED)</td>
<td>MEM / ADITYA STEEL / BEC / INDIANA</td>
</tr>
<tr>
<td>K)</td>
<td>RACEWAY / MS TRUNKING</td>
<td>MEM / ADITYA STEEL / BEC</td>
</tr>
<tr>
<td>L)</td>
<td>LIGHTING FIXTURES / FLOOD LIGHTS (INDOOR &amp; OUTDOOR)</td>
<td></td>
</tr>
<tr>
<td>i)</td>
<td>INDOOR</td>
<td>PHILIPS / HAVELLS / WIPRO</td>
</tr>
<tr>
<td>ii)</td>
<td>OUTDOOR</td>
<td>PHILIPS / BAJAJ / JAQUAR LIGHTING /</td>
</tr>
<tr>
<td>M)</td>
<td>FLAME PROOF LIGHT FIXTURES</td>
<td>BAJAJ / CROMPTON GREIVES</td>
</tr>
<tr>
<td>N)</td>
<td>FLAME PROOF SOCKETS</td>
<td>SCHNEIDER / BALIGA / SUDHIR</td>
</tr>
<tr>
<td>O)</td>
<td>OCCUPANCY SENSORS</td>
<td>HONEYWELL / HIK VISION / PHILIPS / LEGRAND / WIPRO</td>
</tr>
<tr>
<td>P)</td>
<td>FANS &amp; EXHAUST FANS</td>
<td>CROMPTON GREAVES / GE - ALSTOM / ORIENT</td>
</tr>
<tr>
<td>Q)</td>
<td>AIR CIRCULATORS</td>
<td>ALMONARD / CGL / GE - ALSTOM</td>
</tr>
<tr>
<td>R)</td>
<td>EXHAUST FANS ( PVC Body)</td>
<td>CROMPTON GREAVES / GE - ALSTOM / ORIENT</td>
</tr>
<tr>
<td>S)</td>
<td>MAINTENANCE FREE EARTHING</td>
<td>UNIVERSAL EARTHING SOLUTIONS / ERICO</td>
</tr>
<tr>
<td>T)</td>
<td>L.T. PANEL MANUFACTURERS</td>
<td>M/S. CONQUERENT CONTROL SYSTEMS PVT. LTD. Gurgaon</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M/s. Shivam Instruments &amp; Controls Pvt. Ltd Gurgaon</td>
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<tr>
<td></td>
<td></td>
<td>M/s. INDIA TECH Faridabad</td>
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<tr>
<td></td>
<td></td>
<td>M/s. RISHA CONTROL Delhi</td>
</tr>
<tr>
<td>U)</td>
<td>GI POLE</td>
<td>BAJAJ / VALMOUNT</td>
</tr>
<tr>
<td>V)</td>
<td>Compact sub station</td>
<td>SIEMENS, ABB, CONCURRENT</td>
</tr>
<tr>
<td>W)</td>
<td>UPS</td>
<td>EMERSION, SCHNIDER, LEGRAND, EATON</td>
</tr>
<tr>
<td>X)</td>
<td>DG set</td>
<td>KOEL GREEN, SUDHIR, JACKSON,</td>
</tr>
<tr>
<td></td>
<td>EPABX</td>
<td>PANASONIC, AE TEL</td>
</tr>
<tr>
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</tr>
<tr>
<td>Z1</td>
<td>Network rack</td>
<td>LEGRAND</td>
</tr>
<tr>
<td>Z2</td>
<td>Patchcord</td>
<td>DLINK,</td>
</tr>
<tr>
<td>Z3</td>
<td>Lift</td>
<td>SCHINDLER, KONE, OTIS, THYSEN</td>
</tr>
<tr>
<td>Z4</td>
<td>HT/LT Panel</td>
<td>L&amp;T/CROMPTON/ABB</td>
</tr>
<tr>
<td>Z5</td>
<td>Pumps</td>
<td>GROUNDFOS/ CROMPTON/</td>
</tr>
</tbody>
</table>
Software Technology Parks of India, is an Autonomous Society set up by the Ministry of Electronics and Information Technology (MeitY), Government of India in 1991, with the objective of encouraging, promoting and boosting the Software Exports from India.

Software Technology Parks of India maintains internal engineering resources to provide consulting, training and implementation services. Services cover Network Design, System Integration, Installation, Operations and maintenance of application networks and facilities in varied areas.

The objectives of the Software Technology Parks of India are:

(a) To promote the development and export of software and software services including Information Technology (I.T.) Enabled Services/ Bio-IT.

(b) To provide statutory and other promotional services to the exporters by implementing Software Technology Park/ Electronics and Hardware Technology Park Schemes and other such schemes which may be formulated and entrusted by the Government from time to time.

(c) To provide data communication services including value added services to IT / IT Enabled Services related industries.

(d) To promote micro, small and medium entrepreneurs by creating conducive environment for entrepreneurship in the field of IT / IT Enabled Services

- Gorakhpur Industrial Development Authority (GIDA) has provided the 14500 sqm land

Location of IT Park will be Plot No.-GH-1, BL-5 in sector-7, GIDA Gorakhpur
## PROPOSED STPI Incubation Centre at Gorakhpur

### BUILDING SPECIFICATIONS

<table>
<thead>
<tr>
<th>S.No</th>
<th>ITEM</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td><strong>Foundation</strong></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Foundation</td>
<td>- Isolated/combined foundation as per Geotech report recommendation as per structure design.</td>
</tr>
<tr>
<td>2.0</td>
<td><strong>Superstructure</strong></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Superstructure</td>
<td>- RCC framed construction with fly ash mix minimum 25% Fly ash brick masonry work 230 mm thick in cement mortar 1:6.</td>
</tr>
<tr>
<td>2.2</td>
<td></td>
<td>- Internal partition –fly ash brick masonry work for half brick wall masonry in cement mortar 1:4 with appropriate reinforcement.</td>
</tr>
<tr>
<td>3.0</td>
<td><strong>JOINERY WORK</strong></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td><strong>Door( Frame, Shutter)</strong></td>
<td></td>
</tr>
<tr>
<td>3.1.1</td>
<td>All Cabins</td>
<td>- Door frames Pressed Metal Frame OR - Frameless toughened glass door with SS Handle.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Flush Door Shutters finished with laminate - Flush door shutters for PV &amp; CCE office finished with superior grade laminate</td>
</tr>
<tr>
<td>3.1.2</td>
<td>WC Door</td>
<td>- UPVC door shutters.</td>
</tr>
<tr>
<td></td>
<td>Main Door</td>
<td>- Toughened glass hinged door shutters</td>
</tr>
<tr>
<td>3.2</td>
<td><strong>Windows( Frame, Shutter)</strong></td>
<td></td>
</tr>
<tr>
<td>3.2.1</td>
<td>External windows</td>
<td>- Structural glazing &amp; Powder coated Aluminum sections with heat insulating reflective glass.</td>
</tr>
<tr>
<td>3.2.2</td>
<td>Internal courtyard</td>
<td>- Windows / door shutters in Aluminum frame/section with heat insulating single glazed reflective glass.</td>
</tr>
<tr>
<td>3.3</td>
<td>Interior partition Work</td>
<td>- Part of Interior Estimate</td>
</tr>
<tr>
<td>4.0</td>
<td>FLOORING</td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>INTERNAL FLOORING</td>
<td></td>
</tr>
<tr>
<td>4.1.1</td>
<td>Officer’s Room, Low ht Cabins, work stations, Plug &amp; Play</td>
<td>- Glossy vitrified tile flooring. (Vermora, Kajaria, Somani or equivalent 60x60cm)</td>
</tr>
<tr>
<td>4.1.2</td>
<td>Lounge &amp; Rooms</td>
<td>- Glossy vitrified tile flooring. (Vermora, Kajaria, Somani or equivalent 60x60cm)</td>
</tr>
<tr>
<td>4.1.3</td>
<td>Toilets &amp; Kitchens</td>
<td>- Matt finished vitrified tile flooring. (Vermora, Kajaria, Somani or equivalent 60x60cm)</td>
</tr>
<tr>
<td>4.1.4</td>
<td>Entrance Lobby, Lift lobby, Reception &amp; waiting</td>
<td>- High Gloss vitrified tile flooring. - (Vermora, Kajaria, Somani or equivalent 60x120cm)</td>
</tr>
<tr>
<td>4.1.5</td>
<td>Atrium, Entrance Steps &amp; Staircase</td>
<td>- Granite flooring</td>
</tr>
<tr>
<td>4.1.6</td>
<td>Meeting &amp; Conference Room</td>
<td>- Romano Wooden Vitrified Tile (Vermora, Kajaria, Somani or equivalent) flooring</td>
</tr>
<tr>
<td>4.1.7</td>
<td>Atrium</td>
<td>- Matt finished vitrified tile flooring. (Vermora, Kajaria, Somani or equivalent 60x60cm)</td>
</tr>
<tr>
<td>4.1.8</td>
<td>Circular Corridors</td>
<td>- Granite flooring</td>
</tr>
<tr>
<td>4.1.9</td>
<td>Cafeteria, Training, Faculty Room &amp; Multipurpose room</td>
<td>- Glossy vitrified tile flooring. - (Vermora, Kajaria, Somani or equivalent 60x60cm)</td>
</tr>
<tr>
<td>4.2</td>
<td>EXTERNAL FLOORING</td>
<td></td>
</tr>
<tr>
<td>4.2</td>
<td>- Polished / Flamed Granite flooring in porch - Cement concrete flooring in the service areas. - Green interlocking paver blocks in parking area outside building. - Crazy Tile Flooring With Ceramic Tiles on terrace. - Kota Stone in rear platform &amp; steps. - Flamed Granite Flooring in Entrance Ramp &amp; Rear Small platform. - For Roof Exposed to Sun (with 19mm thick closed cell elastomeric insulation material in the form of under deck)</td>
<td></td>
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<tr>
<td>5.0</td>
<td>FINISHING</td>
<td></td>
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</tbody>
</table>
| 5.1 | **External walls** | - Tractor emulsion, having VOC (Volatile Organic Compound) content less than 5 grams/liter.  
- Granite Stone Cladding up to sill level in ground Floor. |
| 5.2 | **Internal walls** | - Plastered & finished with plaster of Paris wherever specified.  
- Acrylic emulsion paint of interior grade, having VOC (Volatile Organic Compound) content less than 50 grams/liter.  
- Glazed ceramic tile dado in toilets up to 2100 ht  
- Vitrified tile dado in officer's toilet, PH toilet & PD Pantry up to 2100 ht.  
- Glass Mosaic finish tiles dado in officers/PD toilets |
| 5.3 | **False Ceiling** | - Plaster of Paris Ceiling, Gyp. Board ceiling, Armstrong Grid Ceiling, Metal grid ceiling (In Toilet & pantry).  
- Laminate finish over 9 mm thick commercial ply  
- Superior Grade laminate finish over 9 mm thick MDF Board  
- Plastic Emulsion paint finishing at false ceiling. |
| 6.1 | **Wall Paneling** | - 1 mm thick laminate over MDF over 9 mm thick MDF over MS tubular frame. |
| 6.0 | **Sanitary fixtures** | **Jaquar Sanitary fixtures** |
| 6.1.1 | WC in Officer's Toilet | - Wall Hung European WC with low level Slim Concealed Cistern. |
| 6.1.2 | General Toilet WC | - Wall Hung European WC with low level flushing Cistern. |
| 6.2 | Urinal | - Automatic sensor operated low flow urinal |
| 6.3 | Low flow tap | - Low flow tap provided |
| 6.4 | **Sanitary fittings** |   |
| 6.4.1 | Water supply pipes | - B-class G.I pipes with anti corrosive coating on exposed surface |
| 6.4.3 | Soil & Water waste pipes | - Hubless centrifugally cast (spun) iron pipes |
| 7.0 | **Door Hardware** |   |
| 7.1 | Officers rooms/Toilets | - SS El drop , SS handles , SS tower bolts, SS door stopper, SS Door buffer , Door closer |