M/s HLL Infra Tech Services Ltd. (HITES)  
(Subsidiary of HLL Lifecare Ltd., A Government of India Enterprise)

Executing Agency of  
Drug & Food Control Organization,  
Government of Jammu & Kashmir

INVITES  
e-TENDER  
FOR  
Construction of Drug Testing Laboratory at Kathua, J&K  
Volume- IV  
Technical Specifications

Tender No. HITES/IDN/DRUG-LAB/KATHUA/2019-20

B-14A, Sector – 62,  
NOIDA (UP) -201307  
Phone no: 0120-4071500, Fax no: 0120-4071513

(March, 2020)
# CONSTRUCTION OF DRUG TESTING LABORATORY
# AT KATHUA, J&K

## Technical Specifications

### INDEX

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Heading</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>A Brief of Requirement of The Work</td>
<td>02</td>
</tr>
<tr>
<td>2.</td>
<td>Technical Specifications and Conditions - Civil Works</td>
<td>05</td>
</tr>
<tr>
<td>3.</td>
<td>Technical Specifications Plumbing &amp; Sanitary Works</td>
<td>61</td>
</tr>
<tr>
<td>4.</td>
<td>Technical Specifications - Horticulture Works</td>
<td>84</td>
</tr>
<tr>
<td>5.</td>
<td>Special Conditions for Electrical Services</td>
<td>87</td>
</tr>
<tr>
<td>6.</td>
<td>Technical Specifications for Electrical Services</td>
<td>98</td>
</tr>
<tr>
<td>7.</td>
<td>Technical Specifications for Substation</td>
<td>107</td>
</tr>
<tr>
<td>8.</td>
<td>Technical Specification-Internal Electrification, Telephone System, and LAN Networking</td>
<td>201</td>
</tr>
<tr>
<td>9.</td>
<td>Technical Specifications for External Street Lighting System</td>
<td>244</td>
</tr>
<tr>
<td>10.</td>
<td>Technical Specifications for UPS System</td>
<td>251</td>
</tr>
<tr>
<td>11.</td>
<td>Technical Specifications for Fire Alarm System</td>
<td>255</td>
</tr>
<tr>
<td>13.</td>
<td>Technical Specifications for HVAC System</td>
<td>321</td>
</tr>
<tr>
<td>14.</td>
<td>Technical Specifications for Fire Fighting</td>
<td>379</td>
</tr>
<tr>
<td>15.</td>
<td>Technical Specifications for STP, ETP, WTP and Portable RO Works</td>
<td>395</td>
</tr>
<tr>
<td>16.</td>
<td>Technical Specifications for Lifts</td>
<td>424</td>
</tr>
<tr>
<td>17.</td>
<td>Technical Specifications for Gas &amp; Vacuum Piping System</td>
<td>435</td>
</tr>
<tr>
<td>18.</td>
<td>List of Approved Makes</td>
<td>470</td>
</tr>
</tbody>
</table>
CONSTRUCTION OF DRUG TESTING LABORATORY
AT KATHUA, J&K

Chapter 1

A BRIEF REQUIREMENT OF THE WORK:

1. Introduction:
The scope of work relates to Construction of Drug Testing Laboratory at Kathua, J & K. The building consists of Ground plus Two Floors with infrastructure facilities including Boundary Wall & External Development Works.

The scope of work shall include Electrical works, Mechanical works, Electronic works, Plumbing, Sanitary, Sewerage, Storm water drainage, & Fire-Fighting works etc. & preparation of all detailed shop drawings, obtaining approval from all local authorities, electrical inspector, water, sewer, drainage, electricity connection from local bodies, permission/ approval for tree re-plantation, etc. to be executed as integral part of the project. The following are the salient features of the Works:

b. Super Structure.
c. Water Proofing Treatment Works.
d. Clean Room Partitions and Doors.
e. Aluminium Door and Windows.
f. Structural Glazing Work.
g. Anti-Termite Chemical Treatment.
h. Internal and External Water Supply, Sewerage, Storm Water Drainage.
i. Infrastructure Development I.E. Roads, Pathways, Etc.
j. Electrical Installation (Internal & External).
k. Fire Fighting System.
l. HT & LT Installation, Substation, DG Sets.
m. HVAC
n. Lifts
o. Fire Alarm, PA, CCTV, EPABX/Telephone, LAN Systems, Etc.
p. ETP, STP.
q. Landscape & Horticulture Works.

2. General
i. The work shall in general conform to the Latest CPWD Specifications (corrected up to the last date of submission/uploading of bid). Work under this Contract shall consist of furnishing all labour, materials, equipment, tools & plants and appliances necessary and required.
Regarding testing of civil & electrical & other materials, the testing of materials shall be conducted in Govt. Laboratory/ Govt. Engineering Colleges/ IITs/ NITs or from the laboratory approved by Engineer-in-charge. The charges of testing of materials in approved laboratory shall be borne by the Contractor.

ii. Contractor should spray curing water on concrete structure and shall not allow free flow of water. Concrete structures should be kept covered with thick cloth/gunny bags and water should be sprayed on them. Contractor shall do water ponding on all sunken slabs using cement and sand mortar.

iii. Specification/brands names of materials to be used as per the scope of work are listed in the bid documents. The efforts should be made by the Contractor to use indigenous products. The Contractor should also consider the availability of spares parts/ components for maintenance purposes while proposing any brand/manufacturer. The materials of any other brand/manufacturer may be proposed for use by the Contractor in case the brands specified below are not available in the market and/or Contractor intends to use some other brand better than the brands mentioned in the document. The alternate brand can be used only after the approval of Engineer-in-Charge. The list of approved makes is appended to this document.

iv. Contractor shall submit credentials of the agencies proposed to be engaged by him/them for execution of specialized works to the HITES. Particular agency shall be approved by HITES and only such agencies shall be allowed to execute the work on behalf of the contractor.

v. CPWD Specifications for Civil, Electrical and all other works with up to date correction slips for all sub heads of work as applicable, and, Technical Specifications included in the tender documents, wherever applicable.

vi. The work shall, in general, conform to the CPWD Specifications for Civil, Electrical and all other works with up to date correction slips for all sub heads of work as applicable, and, Technical Specifications included in the tender documents, wherever applicable. Wherever any aspect of design / construction / material standards is not covered under the above mentioned specification, relevant standards shall be referred to in the order of precedence which shall be as follows. In the case of discrepancy between the Schedule of Quantities, the Specifications and /or the Drawings, the following order of preference shall be observed –

a. Description of Schedule of Quantities.

b. Particular Specification and Specific Condition, if any.

c. Drawings.

d. CPWD Specifications.

e. Indian Standard Specifications of BIS/ NBC/ IRC/ BS/ ASTM/ DIN

For items not covered by any of the above, the work shall be done, as per sound engineering practices and as directed by the Engineer-in-charge.
3. Setting Out

i. The Contractor shall carry out survey of the whole work area, setting out the layout of building in consultation with the Engineer -in-Charge & proceed further. Any discrepancy between the Engineer-in-charge, architectural drawings and actual layout at site shall be brought to the notice of the Engineer -in-charge. It shall be responsibility of the Contractor to ensure correct setting out of alignment. Total station survey instruments only shall be used for layout, fixing boundaries, and centre lines, etc.

ii. The Contractor shall establish, maintain and assume responsibility for grades, lines, levels and benchmarks. He shall report any errors or inconsistencies regarding grades, lines, levels, dimensions etc. to the Engineer -in-charge before commencing work. Commencement of work shall be regarded as the Contractor's acceptance of such grades, lines, levels, and dimensions and no claim shall be entertained at a later date for any errors found.

iii. If at any time, any error appears due to grades, lines, levels and benchmarks during the progress of the work, the Contractor shall, rectify such error, if so required, to the satisfaction of the Engineer -in-Charge.

iv. Though the site levels are indicated in the drawings, the Contractor shall ascertain and confirm the site levels with respect to benchmark from the concerned authorities. The Contractor shall protect and maintain temporary/ permanent benchmarks at the site of work throughout the execution of work. These benchmarks shall be got checked by the Engineer-in-Charge or his authorized representatives. The work at different stages shall be checked with reference to benchmarks maintained for the said purpose.

v. The approval by the Engineer-in-Charge, of the setting out by the Contractor, shall not relieve the Contractor of any of his responsibilities and obligation to rectify the errors/ defects, if any, which may be found at any stage during the progress of the work or after the completion of the work.

vi. The Contractor shall be entirely and exclusively responsible for the horizontal, vertical and other alignments, the level and correctness of every part of the work and shall rectify effectively any errors or imperfections therein. Such rectifications shall be carried out by the Contractor to the entire satisfaction of the Engineer -in-Charge.

vii. The contractor(s) shall carry out soil/geotechnical investigation and should satisfy himself about complete characteristics of soil and other parameters at site. The intending Contractor shall conduct soil investigations on their own, and shall be responsible for the adequacy of the design.
Chapter 2

TECHNICAL SPECIFICATIONS AND CONDITIONS - CIVIL WORKS

1. General

i. The work shall be carried out in accordance with the Architectural drawings and structural drawings (proof checked/vetted by the approved Institute) and approved by the Engineer-in-Charge. The Technical Specifications are to be read with and in general conforming to the Latest CPWD Specifications.

ii. Contractor(s) shall provide permanent bench marks, flag tops and other reference points for the proper execution of work and these shall be preserved till the end of the work. All such reference points shall be in relation to the levels and locations, given in the Architectural drawings. On completion of work, the Contractor(s) shall submit required number of prints of —as built drawings to the Engineer-in-Charge.

iii. Before commencement of any item of work the Contractor shall correlate all the relevant architectural and structural drawings, and specifications etc. and satisfy him that the information available is complete and unambiguous. The Contractor alone shall be responsible for any loss or damage occurring by the commencement of work based on any erroneous and or incomplete information and no claim whatsoever shall be entertained on this account.

iv. The Contractor(s) should engage approved, licensed plumbers for the work and get the materials (fixtures/fittings) tested, by the municipal Body /Corporation authorities wherever required, at his own cost. The Contractor(s) shall submit for the approval of the Engineer-in-Charge, the name of the plumbing Contractor proposed to be engaged by him.

v. The Contractor shall give performance test of the entire installation(s) as per the specifications in the presence of the Engineer-in-charge or his authorized representative before the work is finally accepted and nothing extra what-so-ever shall be payable to the Contractor for the test.

vi. The work of services will be executed simultaneously. The Contractor shall minimize the scope of making recesses, holes, opening etc. as the same shall be planned in advance and necessary grooves/niches shall be provided in shuttering of RCC.

vii. Sample of building materials, fittings and other articles required for execution of work shall be got approved from the Engineer-in-Charge before use in the work. The quality of samples brought by the Contractor shall be judged by standards laid down in the relevant CPWD/ BIS specifications. All materials and articles brought by the Contractor to the site for use shall conform to the samples approved by the Engineer-in-Charge which shall be preserved till the completion of the work.
viii. BIS marked materials except otherwise specified shall be subjected to quality test at the discretion of the Engineer-in-Charge besides testing of other materials as per the specifications described for the item/material. Wherever BIS marked materials are brought to the site of work, the Contractor shall, if required, by the Engineer-in-Charge, furnish manufacturer’s test certificate or test certificate from approved testing laboratory to establish that the material/procured by the Contractor for incorporation in the work satisfies the provisions of specifications/BIS codes relevant to the material and/or the work done.

ix. The Contractor shall procure the required materials in advance so that there is sufficient time to testing of the materials and clearance of the same before use in the work. The Contractor shall provide at his own cost suitable weighing and measuring arrangements at site for checking the weight/dimensions as may be necessary for execution of work.

x. Contractor shall submit minimum “Quality Assurance” plan which shall consist of:
   a. Lot size, number of required tests and frequency of testing. While deciding these criteria CPWD Specifications & provisions of BIS Code and standard practices may be referred. The mandatory test shall be in conformity with the requirements details in the latest CPWD specifications. For testing of other materials/work, the requirements as per provisions of BIS Code and standard practices shall be applicable.
   b. It should clearly indicate the Machinery and other Tool & Plants required to be deployed at site by the Contractor. Entire Machinery and T&P may not be required at the start of work, therefore, a proper time schedule by which each Machinery & T&P is to be brought at site should also be indicated.
   c. The Contractor shall maintain record of Receipt of Materials, testing of the same & Maintenance of Register of Tests.

xi. All the registers of tests carried out at Construction Site or in outside laboratories shall be maintained by the Contractor, which may be inspected by Engineer-in-charge or his/her designee at any point of time.
   a. The Contractor shall allow access to Third Party Quality Assurance Agency (TPQAA) engaged by HITES/Client to have a control on quality and methodology of execution. Requisite number of Samples of materials including Cement Concrete Cubes shall be taken jointly by Contractor, TPQAA and Engineer-in-charge or their authorized representative. All arrangements for transporting and getting them tested shall be made by the Contractor.
   b. All the test in field lab setup at Construction Site shall be carried out by the Quality control team to be engaged by the Contractor which can be witnessed by Engineer-in-charge or his/her designee. A daily report of Tests to be conducted on a day shall be submitted to Engineer-in-charge or his authorized representative.
   c. All the entries in the registers will be made by the designated Engineering Staff of the Contractor.
   d. The Contractor shall be responsible for safe custody of all the test registers.
e. Submission of copy of all test registers, Material at Site Register and hindrance register along with each alternate Running Account Bill and Final Bill shall be mandatory.

f. All material received at site shall be entered in MAS Register and copy of Supply order, MTC & Bill-invoice shall be maintained in order. The MAS Registers including Cement and Steel Registers shall be maintained by a qualified staff of Contractor which shall be inspected by Engineer-in-charge or his authorized representative at any time. The daily report of receipt of material shall be sent to Engineer-in-charge or his authorized representative.

d. The Contractor shall ensure that no construction leachate (e.g. cement slurry etc.), is allowed to percolate into the ground. Adequate precautions are to be taken to safeguard against this including, reduction of wasteful curing processes, collection, basic filtering and reuse. The Contractor shall follow requisite measures for collecting drainage water run-off from construction areas and material storage sites and diverting water flow away from such polluted areas. Temporary drainage channels, perimeter dike/swale, etc. shall be constructed to carry the pollutant-laden water directly to the treatment device or facility (municipal sewer line).

2. POUR CARD, CHECK-LIST FOR EXECUTION OF WORK

i. As and when any important item is taken up for execution, the Contractor shall submit the specifications and develop a checklist and Pour card. This sample checklist should be got approved from the Engineer-in-charge and should be used at site. This check list should be shown to the Engineer-in-charge or his authorized representative during inspection. This procedure is to be followed for all hidden items, CC/RCC work, Steel reinforcement, shuttering, flooring, doors & windows, plumbing, including water supply pipe lines, roof treatment, earth filling, etc.

ii. The Contractor shall render all help and assistance in documenting the total sequence of this project by way of photography, slides, audio-video recording etc. nothing extra shall be payable to the Contractor on this account.

Note: - All DSR items shall be carried out as per the latest CPWD Specification with up to date correction slip.

1. EARTH WORK: As per relevant CPWD specifications.

i. Irrespective of the stipulations in the relevant CPWD Specifications or elsewhere in the Contract, the surplus excavated earth shall be disposed off by the contractor at his own cost to the place as directed by Engineer – in-charge and/or permitted by the local authority after obtaining written permission of the Engineer – in-charge and no payment will be made by the HITES for disposal of this excavated earth.
ii. The Contractor shall, at his own expense and without extra charges, make provision for all shoring, pumping, dredging or bailing out water, encountered from any sources such as rains, floods, springs, subsoil water table being high or due to any other cause whatsoever. The foundation trenches shall be kept free from water while all the works below ground level are in progress without any extra payment.

iii. Filling in plinth shall be consolidated with water and compacted with pneumatic rammers, to achieve 90% relative density on testing. One test is to be carried out for 1000 Sqm of compacted area.

2. PLAIN CEMENT CONCRETE AND REINFORCED CEMENT CONCRETE WORK:

a. STONE AGGREGATE:
   i. Stone aggregate used in the work shall be of hard broken stone to be obtained from approved source (Quarries to be approved by the Engineer in charge) and shall conform to relevant provision in the Latest CPWD Specifications for works.

b. SAND
   i. Sand to be used for the work shall be of as specified in CPWD specifications 2009. Sand shall be obtained from the source to be got approved by the Engineer in charge and washed if required, with appropriate equipment to bring down the chemical, inorganic and organic impurities within the permissible limits as per the direction of the Engineer in charge. The same shall consist of hard siliceous materials.

   Note: Where only one variety of sand is available the sand will be sieved for use in finishing work as directed by the Engineer – in – charge in order to obtain smooth surface and nothing extra will be paid on this account.

   ii. Nothing extra shall be paid for screening or washing the sand as prescribed above.

   iii. Fly ash conforming to grade 1 of IS 3812 (Part 1) may be used as part replacement of OPC provided uniform blending with cement is ensured in accordance with clauses 5.2 and 5.2.1 of IS 456-2000 in the items of BMC and RMC. However this shall not override the provisions of the respective items.

c. CENTERING SHUTTERING AND SCAFFOLDING:
   i. All Scaffolding centring for RCC shall be with properly designed system and brought to site well in advance so that the progress of the work is not hampered for non-availability of the same.

   ii. All shuttering for RCC work except soffits of slab shall be in water proof shuttering Ply. Shuttering for slab and soffits shall be in water proof shuttering ply or in good quality mild steel plates free of dents, bends or warping and rusting as approved by the Engineer in charge.

   iii. Contractor should deploy complete one set of shuttering materials for minimum one complete floor and the shuttering material for beam bottom shall be minimum for two complete floors.

e. REINFORCEMENT:
i. TMT reinforcement steel shall be used shall be as per design and conforming to IS: 1786 pertaining to Fe 500 OR Fe 550D grade of steel.

ii. TMT steel bars manufactured by main producers, as per list of makes, shall be allowed in the work. Contractor shall produce manufacturer Test Report for each dia and each lot Tests. Nothing extra will be paid for “straightening of bars” received from market in coils or with bends. All incidental charges of any kind whatsoever including cartage, storage, safe custody of materials, cutting and wastage etc. shall be borne by the contractor.

iii. The actual average sectional weight for dia up to 10 mm shall be arrived at from one meter long samples (minimum 3 from each dia) taken from each lot of steel. The discretion of the Engineer – in – charge shall be final for the procedure to be followed for determining the average sectional weight of each lot. Quantity of each diameter of steel received at site of work each day will constitute the single lot for this purpose.

iv. The weight of each lot of a particular diameter of 10mm and below shall be reckoned as the weight as per actual issue multiplied by a factor equal to the standard sectional weight of the particular diameter divided by the average sectional weight of the particular dia in a particular lot worked out as per above para. Adjustment for the steel shall be effected on the basis of the weight as modified above for quantity payable.

v. Measurement of all diameters of steel be on linear basis and will be converted into weight on the basis of standard sectional weight coefficients given in relevant CPWD specifications mentioned in schedule ‘F’ of General Conditions of Contract.

vi. Measurement of reinforcement shall be as per procedure described in the relevant CPWD specifications mentioned in schedule ‘F’ of General Conditions of Contract.

f. Concrete Mix Design

The concrete mix design shall be as specified in IS 456:2000 and CPWD Specifications.

g. Ready Mix Concrete

i. The contractor shall engage Ready Mix Concrete (RMC) producing plants (Distance of plant from site to be approved by Engineer in Charge) to supply RMC for the work. The RMC plant proposed to be engaged by the contractor shall fulfil the following requirements.

   a. It shall be fully computerized.

   b. It should have supplied RMC for Govt. projects.

   c. It should have facility for providing printed advice showing ingredients of concrete carried by each mixer.

   d. The Ready Mix Concrete (RMC) producing plants of the main Cement producers shall be preferred.

ii. The contractor shall, within 30 days of award of the work submit list of at least three reputed RMC plant companies along with details of such plants Including details of transit mixer, pumps etc. to be deployed indicating name of Company, its location, capacity, technical establishment, past experience for approval by Engineer-in-charge.
iii. The Engineer-in-Charge reserves the right to exercise check over the:

a. Concrete including conducting of tests for checking quality of materials recordings of test results and declaring the material fit or unfit for use in production of mix.

b. Calibration check of the RMC.

c. Weight and quality check on the ingredient, water and admixture added for batch mixing.

d. Time of mixing of concrete.

e. Testing of fresh concrete, recordings of results and declaring the mix fit or unfit for use. This will include continuous control on the workability during production and taking corrective action.

For exercising such control, the Engineer shall periodically depute his authorized representative at the RMC plant. It shall be the responsibility of the contractor to ensure that the necessary equipment manpower & facilities are made available to Engineer and/or his authorized representative at RMC plant.

iv. Ingredients, admixtures & water declared unfit for use in production of mix shall not be used. A batch mix found unfit for use shall not be loaded into the truck for transportation.

v. All required relevant records of RMC shall be made available to the Engineer or his authorized representative. Engineer shall, as required, specify guidelines & additional procedures for quality control & other parameters in respect of materials, production and transportation of concrete mix which shall be binding on the contractor & the RMC plant.

vi. It shall be the responsibility of the Contractor to ensure that the RMC producer provides all necessary testing equipment and takes all necessary measures to ensure Quality control of ready mixed concrete. In general the required measures shall be:

a. **Control of Purchased Material Quality**
   
   RMC producer shall ensure that the materials purchased and used in the production of concrete conform to the stipulation of the relevant agreed standards with the material Supplier and the requirement of the product mix design and quality control producer's. This shall be accomplished by visual checks, sampling and testing, certification from materials suppliers and information/data from material supplier. Necessary equipment for the testing of all material shall be provided and maintained in calibration condition at the plant by the RMC producer.

b. **Control of Material Storage**
   
   Adequate and effective storage arrangement shall be provided by RMC producer at RMC plant for prevention of contamination, reliable transfer and feed system, drainage of aggregates, prevention of freeing or excessive solar heating of Aggregate etc.,

c. **Record of Mix Design and Mix Design Modification**
RMC producer shall ensure that record of mix design and mix design modification is available in his computer at RMC plant for inspection of Engineer or his representative at any time.

d. **Computer Print outs of Each Truck Load**
Each truckload / transit mixer dispatched to site shall carry computer printout of the ingredients of the concrete it is carrying. The printout shall be produced to Engineer or his representative at site before RMC issued in work.

e. **Transfer and Weighing Equipment**
RMC Producer shall ensure that a documented calibration is in place. Proper calibration records shall be made available indicating date of next calibration due, corrective action taken etc. RMC producer shall ensure additional calibration checks whenever required by the Engineer in writing to contractor. RMC producer shall also maintain a daily production record including details of mixes supplied. Record shall be maintained of what materials were used for that day’s production including water and admixtures.

f. **Maintenance of Plant, Truck Mixers and Pumps**
Plant, Truck Mixers and Pumps should be well maintained so that it does not hamper any operation of production, transportation and placement.

g. **Production of Concrete**
The following precautions shall be taken during the production of RMC at the plant

i. **Weighing** (correct reading of batch data and accurate weighing):- For each load, written, printed or graphical records shall be made of the weights of the materials batched, the estimated slump, the total amount of water added to load the delivery tickets number for that load and the time of loading the concrete into the truck.

ii. **Visual observation of concrete during production and delivery or during sampling and testing of fresh concrete assessment of uniformity, cohesion, workability adjustment to water content.** The workability of the concrete shall be controlled on a continuous basis during production. The batch mix found unfit shall not be loaded into the truck for transportation. Necessary corrective action shall be taken in the production of mix as required for further batches.

iii. **Use of adequate equipment at the plant to measure surface moisture content of aggregates, particularly fine aggregates or the workability of the concrete, cube tests etc. shall also be ensured.**

iv. **Making corresponding adjustment at the plant automatically or manually to batched quantities to allow for observed, measured or reported changes in materials or concrete qualities.**

v. **Sampling of concrete, testing monitoring of results.**

vi. **Diagnosis and correction of faults identified from observations / complaints.**

vii. **The RMC plant produced concrete shall be accepted by Engineer-in –Charge at site after receipt of the same after fulfilling all the requirements of mix mentioned in the tender documents.**
viii. The Item of design mix cement concrete is inclusive of all the ingredients including admixtures, if required, labour, machinery T&P etc. required for a design mix concrete of required strength and workability, and, shall take into account change, if any, in quantities of concrete, ingredients like cement and aggregates and admixtures etc. as per the approved mix design.

ix. Ready mix concrete shall be arranged in quantity as required at site of work. The ready mix concrete shall be supplied as per the pre-agreed schedule approved by Engineer.

x. Frequency of sampling and standards of acceptance shall be as per CPWD specifications.

xi. No addition of water or other ingredients shall be permitted in the RMC at site or during transit.

xii. The RMC shall be placed by pump of suitable capacity and the arrangements shall be made to arrange sufficient length of pipe at site to place the RMC in the minimum required time.

xiii. Pre delivery tickets shall be produced with each truck load of RMC.

xiv. The representative of RMC supplier shall attend the site meetings as and when decided by the Engineer.

The contractor shall assess the quantity of RMC requirement at site well in advance and order accordingly to the RMC supplier. It shall be the responsibility of the contractor to arrange requisite quantity of RMC available at site, so that there is no hindrance to the work on this account.

3. WATER PROOFING TREATMENT BY CHEMICAL INJECTION SYSTEM (PRE-CONSTRUCTION)

Water Proofing Treatment (Pre-Construction) by Chemical Injection System

Horizontal Surface (Raft Slab)

i. Before the raft reinforcement is placed in position:
   a. Laying PCC as per drawings and specifications.
   b. Cement slurry (cement and approved water proofing compound) is spread on the PCC for proper bonding with subsequent water proofing treatment.
   c. Water Proofing Course of 20mm thick cement mortar 1:4 (1 cement: 4 coarse sand) mixed with approved water proofing compound is laid over the slurry. Stone aggregates 12mm down is embedded at random.
   d. After 24 hours, spreading cement slurry (cement and approved water proofing compound) on the 1st layer of mortar.
   e. Providing and laying 2nd layer of 20mm thick cement mortar 1:4 (1 cement: 4 coarse sand) mixed with approved water proofing compound. Stone aggregate 12mm down size is embedded at random.

ii. After reinforcement of raft is placed in position:
   a. Providing and fixing 25mm dia GI threaded grouting nozzles of adequate length at the specified locations @ 1.50 meters c/c or as shown in the drawing all over the slab.
The grouting nozzles are tied with reinforcement in such a manner as not to choke its end during concrete operations. The top of these nozzles protrudes above the raft concrete.

b. After minimum 7 days of concreting, cement grout of cement and approved water proofing compound (non-shrinkage grouting compound) in proportion as specified is injected, through these nozzles at the pressure of 2.5 to 3.0 Kg/Sq.cm.

c. After grouting, top of the nozzles is cut and the space is filled with cement mortar 1:2 (1 cement: 2 coarse sand) mixed with approved water proofing compound.

Retaining Wall

a. The external surface is prepared and approved cement slurry is applied.

b. Providing and laying 25mm thick cement mortar in 1:4 (1 cement: 4 coarse sand) mixed with approved water proofing compound in two layers with chicken wire mesh 26 or 24 gauge 25mm size in between the two layers.

c. The G.I. pipes are placed at 1.5m c/c in both directions, and, 0.75 m C/C along construction joints and securely fastened to the reinforcement prior to shuttering and concreting or alternately by drilling holes (25mm to 32mm dia) in the concrete up to a depth as shown in the drawing all over the wall surface @ 1.50mt. C/C and as shown in the drawing. Treatment along all construction joints by providing nozzles, as above, shall also be executed.

d. Fixing 25mm dia G.I. threaded nozzles in these holes with cement mortar 1:4 (1 cement: 4 coarse sand) mixed with water proofing compound.

e. Injecting cement grout of cement and polymer based water proofing compound (non-shrinkage grouting compound) in proportion as specified in these nozzles at a pressure of 2.5 to 3.0 Kg/Sq.cm.

f. After the grout the nozzles are cut and filled with cement mortar 1:2 mixed with polymer based water proofing compound in proportion as specified and finished smooth.

Note: The proportion of approved water proofing compound to be used in respect of ordinary cement shall be as per manufacturer’s specifications.

Guarantee for Water Proofing:

Work to be get executed through a approved specialized agency & covered by a 10 years guarantee by the main contractor against leakage, seepage and dampness etc. for which necessary performance guarantee for requisite indicated value of work shall be furnished by the contractor before completion.

13.3 Integral Cement Based Water Proofing Treatment for Roof / Sunken Floors of W.C’s etc.

a. The proprietary water proofing compound shall conform to IS 2645 – 1975 in cement based water proofing treatment, stone aggregate shall be used instead of brick aggregate without any extra cost wherever required by the Engineer in – charge.
b. The finished surface after water proofing treatment shall have required slope.
c. While treatment of sunken floors is done it shall be ensured that the ‘S’or ‘P’traps as the case may be have been fixed / eased and rounded off properly the work shall be carried out as per relevant CPWD specifications.
d. GURANTEE: The above water proofing treatment shall be covered by a 10 years guarantee by the main contractor against leakage, seepage and dampness etc. for which necessary performance shall be furnished by the contractor.

13.4 Water Proofing Treatment Integral Crystalline Waterproofing Materials
Integral Crystalline Waterproofing Admixture
i. Materials
Integral Crystalline Admix is one part cementations powder consisting of hydrophilic chemicals such as Portland cement, very fine treated silica sand and various active, proprietary chemicals. These active chemicals react with the moisture in fresh concrete with the by-products of cement hydration to cause a catalytic reaction, which generates a non-soluble crystalline formation throughout the pores and capillary tracts of the concrete. Thus the concrete becomes permanently sealed against the penetration of water or liquids from any direction. The concrete is also protected from deterioration due to harsh environmental conditions.

ii. Technical Specification/Parameters
The integral crystalline waterproofing admixture shall confirm to the following requirements:

a. At the manufacturers recommended dosage,

i. Material must fulfill the requirements of American concrete institute guidelines ACI-212-3R-10, the coefficient of permeability should be measured for penetration of water. Under hydrostatic pressure of 72.5 psi (5 bars) to 150 psi (10 bars) for 72 to 96 hours as per DIN 1048 Part V. Reduction of water penetration should be 50 to 90%.

ii. The performance of the crystalline admixture must not be restricted by water/cement ratio of the concrete mix. In other words, the crystalline admixture must perform at any water / cement ratio of the concrete mix.

b. The product has no corrosion effect on reinforcement steel according to test norm DIN V 18998. The maximum chloride content lies less than 0.1% and maximum alkali content less than 9.3%.

c. The integral crystalline admixture must be compatible with any other concrete admixture confirming to ASTM D494 and IS 9103.

d. It will not be affected by wear abrasion of the treated concrete surface and crystalline treated concrete shall not require protection layer.

e. The recommended crystalline admixture shall be non-toxic and shall confirm to NSF 61 USA.
Note - The manufacturer shall produce relevant test certificates as per relevant code as stated above.

iii. Recommended Uses: - In locations such as Foundations / Rafts, Sewage and Water Treatment Plants, Parking Structures Basement Retaining Walls etc.

iv. Direction for use Dosage - 0.80% by weight of cement content per cubic meter of reinforced concrete.

v. Preparation of mixing
Mix integral crystalline admixture with water to form a very thin slurry (e.g. 40 lbs (18 kg) of powder mixed with 6 gallons (22.7 ltr) of water). Pour the required amount of material into the drum of the ready-mix truck and mix for at least 5 minutes to ensure even distribution of integral crystalline admixture throughout the concrete.

vi. Application
Concrete treated with integral crystalline admixture should be placed and finished in accordance with good concrete practices. ACI guidelines and recommendations should be observed.

vii. Precaution / Special Consideration
It is important to obtain a homogeneous mixture of crystalline admixture with the concrete. Therefore, do not add dry crystalline admixture powder directly to wet concrete as this may cause clumping and through dispersion will not occur. When incorporating integral crystalline admixture, the temperature of the concrete mix should be above 40ºF (4ºC).

viii. Storage / Shelf life
Integral crystalline admixture must be stored dry at a minimum temperature of 45ºF (7ºC) and its shelf life is one year when stored under proper conditions.

Integral Crystalline Slurry

i. Materials
Integral crystalline slurry is a surface-applied, integral crystalline waterproofing material, which waterproofs and protects concrete in-depth. It consists of Portland cement, specially treated quartz sand and a compound of active chemicals. Integral crystalline slurry needs only to be mixed with water prior to application. When Integral crystalline slurry is applied to a concrete surface, the active chemicals react with moisture and the by-products of cement hydration to cause a catalytic reaction which generates an insoluble, crystalline structure. These crystals fill the pores and minor shrinkage cracks in the concrete to prevent any further water ingress (even under pressure). However, Integral crystalline slurry will still allow the passage of vapour through the structure (i.e. the concrete will be able to “breathe”). Even after the concrete has cured, Integral crystalline slurry remains...
dormant in the concrete and will reactivate in the presence of moisture to seal capillary tracts and hairline cracks. In addition to waterproofing the structure, Integral crystalline slurry protects concrete against seawater, wastewater, aggressive ground water and many other aggressive chemical solutions. Integral crystalline slurry is approved for use in contact with potable water, and is therefore suitable for use in water storage tanks, reservoirs, water treatment plants, etc. Integral crystalline slurry is not a decorative material.

ii. Technical Specification/Parameters

a. Material must fulfill the requirements of American concrete institute guidelines ACI-212-3R-10, the coefficient of permeability should be measured for penetration of water. Under hydrostatic pressure of 72.5 psi (5 bars) to 150 psi (10 bars) for 72 to 96 hours as per DIN 1048 Part V. Reduction of water penetration should be 50 to 90%.


c. Confirm to EN 1504-3 (For structural repairs – R3, Compressive strength > 25 MPA), supplied from an approved manufacturing unit having CE approval conforming to EN 1504-3-R3.

d. The product has no corrosion effect on reinforcement steel according to test norm DIN V 18998. The maximum chloride content lies less than 0.1% and maximum alkali content less than 9.3%.

Note - The manufacturer shall produce relevant test certificates as per relevant code as stated above.

iii. Recommended Uses: - In locations such as Foundations / Rafts, Sewage and Water Treatment Plants, Parking Structures Basement Retaining Walls etc.

iv. Surface Preparation

All concrete to be treated with Integral crystalline slurry must be clean and have an —open‖ capillary surface. Remove laitance, dirt, grease, etc. by means of high pressure water jetting, wet sandblasting or wire brushing. Faulty concrete in the form of cracks, honeycombing, etc. must be chased out, treated with Integral crystalline slurry and filled flush with crystalline mortar. Surfaces must be carefully pre watered prior to the Integral crystalline slurry application. The concrete surface must be damp but with no wet sheen on the surface.

v. Preparation of Material
Integral crystalline slurry is mechanically mixed with clean water to a creamy consistency or that resembling thick oil. Mix only as much material as can be used within 20 minutes and stir mixture frequently. If the mixture starts to set do not add more water, simply re-stir to restore workability.

vi. Mixing Ratios

<table>
<thead>
<tr>
<th>Application</th>
<th>Vertical Surfaces</th>
<th>Horizontal Surfaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brush Application</td>
<td>4 parts integral crystalline slurry to 2 parts water</td>
<td>3 parts integral crystalline slurry to 1 part water</td>
</tr>
<tr>
<td>Spray Application</td>
<td>5 parts integral crystalline slurry to 2.75-3.25 parts water</td>
<td></td>
</tr>
</tbody>
</table>

vii. Application

Crystalline slurry is prepared by mixing 1.00 kg of crystalline slurry with 400 ml of water and applying the same from internal side with the help of synthetic fiber brush @0.70 kg per sqm per coat in two coats after cleaning the entire concrete surface thoroughly with high pressure water jet / wire brush or by mechanical means to make it free from loose particles, dust and dirt etc. and making the surface saturated with water before application of crystalline slurry. Second coat shall be applied within 4-6 hours of first coat.

Apply integral crystalline slurry in two coats by masonry brush or appropriate power spray equipment.

The second coat is applied while the first coat is still — green.

viii. Application Rates

For vertical surface - Two slurry coats of Integral crystalline slurry at 0.70 kg per sqm per coat for horizontal surface – One slurry coat of Integral crystalline slurry at 1.10 kg per sqm.

ix. Post Treatment

The treated areas shall be kept damp for a period of five days and be protected against direct sun, wind and frost, by covering with polyethylene sheeting, damp burlap or similar.

x. Precaution / Special Consideration

Do not apply Integral crystalline slurry at temperatures at or below freezing or to frozen or freezing surfaces. Integral crystalline slurry cannot be used as an additive to concrete or plasters. (Integral crystalline admixture should be considered for these applications).

xi. Storage / Shelf Life

When properly stored in a dry place in unopened and undamaged original packaging its shelf life is 12 months.
**Integral Crystalline Dry-Shake**

**i. Materials**

Integral crystalline dry shake of hydrophilic in nature is a unique chemical treatment material for the waterproofing and protection of concrete. Integral crystalline dry shake has been specially formulated for dry-shake applications on horizontal concrete surfaces where greater impact and abrasion resistance is required. Packaged in the form of a dry powder compound, Integral crystalline dry shake consists of Portland cement, various active proprietary chemicals, and a synthetic aggregate hardener that has been crushed and graded to particle sizes suitable for concrete floors. Integral crystalline dry shake becomes an integral part of the concrete surface, thereby eliminating problems normally associated with coatings (e.g. scaling, dusting, flaking and delamination). The active chemicals react with the moisture in the fresh concrete causing a catalytic reaction, which generates a non-soluble crystalline formation within the pores and capillary tracts of the concrete.

**ii. Technical Specification/Parameters**

a. Material must fulfill the requirements of American concrete institute guidelines ACI-212-3R-10, the coefficient of permeability should be measured for penetration of water. Under hydrostatic pressure of 72.5 psi (5 bars) to 150 psi (10 bars) for 72 to 96 hours as per DIN 1048 Part V. Reduction of water penetration should be 50 to 90%.


c. Confirm to EN 1504-3 (For structural repairs – R3, Compressive strength > 25 MPA), supplied from an approved manufacturing unit having CE approval conforming to EN 1504-3-R3.

d. The product has no corrosion effect on reinforcement steel according to test norm DIN V 18998. The maximum chloride content lies less than 0.1% and maximum alkali content less than 9.3%.

**iii. Recommended Uses:**

Raft/Foundation Slabs, Below-grade Structures Sewage and Water Treatment Plants Traffic Bearing Surfaces Warehouse Floors Parking Structures etc.

**iv. Directions for Application**

a. Application Rates

Under normal conditions, the coverage rate for Integral crystalline dry shake is 0.60 kg per sqm depending on the degree of abrasion resistance required.

b. Application Procedure

Integral crystalline dry shake is to be sprinkled @ 0.60 kg per sqm over the PCC blinding, after fixing the reinforcement bars on the cured PCC so as to achieve positive side waterproofing below the raft concrete, as per the manufactures specification.
c. **Curing**

Curing is important and shall begin as soon as final set has occurred but before surface starts to dry. Conventional moist curing procedures such as water spray, wet burlap or plastic covers may be used. Curing shall continue for at least 48 hours.

v. **Precaution / Special Consideration**

For the best results when applying dry shake materials, the air content of the concrete shall not exceed 3% (a high air content can make it difficult to achieve a proper application).

In hot, dry, or windy conditions, it is advisable to use an evaporation retardant on the fresh concrete surface to prevent premature drying of the slab.

Chronic moving cracks or joints will require a suitable flexible sealant.

vi. **Storage / Shelf Life**

Integral crystalline dry shake must be stored dry at a minimum temperature of 45ºF (7ºC) and its shelf life is one year when stored under proper conditions.

**Crystalline Mortar**

i. **Materials**

Crystalline mortar consists of Portland cement, specially treated quartz sand and a compound of active chemicals. The active chemicals react with moisture and the by-products of cement hydration to cause a catalytic reaction, which generates an insoluble integral crystalline complex. These crystalline complexes grow in the presence of water, block the capillaries of the concrete and minor shrinkage cracks, thus waterproofing it. Chemical activation begins when the powder is mixed with water and may take several days to completely block the capillaries depending on ambient temperature and environmental conditions.

ii. **Technical Specification/Parameters**

a. Material must fulfill the requirements of American concrete institute guidelines ACI-212-3R-10, the coefficient of permeability should be measured for penetration of water. Under hydrostatic pressure of 72.5 psi (5 bars) to 150 psi (10 bars) for 72 to 96 hours as per DIN 1048 Part V. Reduction of water penetration should be 50 to 90%.

b. Bond strength: ≥ 1.5 MPA (Class – R3).

c. Potable Water Compatibility: Nontoxic and suitable for use in potable water facilities – NSF

d. Listed as per ANSI 61 listing.

e. Confirm to EN 1504-3 (For structural repairs – R4, Compressive strength > 45 MPA), supplied from an approved manufacturing unit having CE approval conforming to EN 1504-3-R4.
f. The product has no corrosion effect on reinforcement steel according to test norm DIN V 18998. The maximum chloride content lies less than 0.1% and maximum alkali content less than 9.3%.

iii. **Recommended Uses**

Applied in conjunction with integral crystalline slurry coat for:

a. Installation of seal strips, reglets and coves at joints to assure water tightness.
b. Patching of tie holes and faulty construction joints.
c. Patching and filling of routed out cracks.
d. Repairing of spalled and honeycombed areas.

iv. **Surface Preparation**

All surfaces to be patched, repaired or sealed with crystalline mortar must be clean and sound. **Cracks** shall be routed out to a U-shaped configuration, approximately (20-25 mm) wide and a minimum of (20-25 mm) deep. **Tie holes** should be roughened prior to filling. **Spalled and honeycombed areas** must be thoroughly cleaned and chiselled back to sound concrete prior to repair. Remove all dirt, cement laitance, form release agents, curing compounds, paints, coatings, etc. by means of wet or dry sandblasting, high pressure water jet or other suitable mechanical means. Surfaces must be well moistened to a dull dampness at the time of application. The concrete should be damp with no wet seen on the surface.

v. **Preparation of Material**

For routed cracks, coves and non-moving joints, add water to crystalline mortar until a medium stiff, trowel able consistency is reached. The texture of the mix should be pliable enough to be trowelled into the cracks with some pressure, but not so pliable that it would run out or sag out of the crack. Approximate mixing ratio (by volume) is 4.5 parts powder to 1 part water. Alternatively, 100 ml of water to 450 gm of crystalline mortar powder. For tie holes and pointing applications, add only a small amount of water. Mixed consistency should be that of —dry earth‖, holding a shape when squeezed in your hand but easily crumbled when pressed between fingers. Mix only as much material as can be used within 20 minutes.

vi. **Application**

a. **For sealing cracks and faulty construction joints**, routed out/making U-shape groove size 25x25mm and then priming the surface with integral crystalline slurry @0.05 kg per running meter and while the surface is tacky filled the cavity up to surface crystalline mortar @1.50 kg per running meter. Once crystalline mortar is touch dry then finally applying two coats of integral crystalline slurry @0.05 kg per running meter per coat.

b. **For repairing spalled & honeycombed areas** prepared the surface and chisel back up to sound concrete and then primed the area with integral crystalline slurry @0.70 kg per sqm. and while the surface is tacky repair and level the honeycomb area with crystalline mortar @ 22.70 kg per sqm. for an average thickness of
10mm. Once crystalline mortar is touch dry then finally two coats of integral crystalline slurry @ 0.70kg per sqm. per coat.

c. For patching of tie rod holes, prepared tie rod hole surface and primed the area with integral crystalline slurry @ 0.07 kg per sqm. and while the surface is tacky repair and filled the tie rod holes with crystalline mortar @ 0.040 kg per hole. The crystalline mortar shall be tightly rodded into tie holes or packed tightly. For 25x25x25 mm hole, use 0.040 kg per hole to fill the tie hole.

vii. Curing

Provide protection against extreme weather conditions such as heavy rain or freezing conditions during the setting period. Curing is not normally required except during hot, low humidity weather. In these conditions a light mist of water approximately 24 hours after the repair is completed will help to ensure a controlled cure. In extreme dry heat, water misting may be required more frequently.

viii. Precaution / Special Consideration

Crystalline mortar shall not applied at temperatures below 40ºF (4ºC), to a frozen substrate or if temperatures will drop below freezing during the curing period (approximately 24 hours). This product is not recommended for use in expansion or construction joints. Crystalline mortar can be applied in (13 mm) layers not exceeding 2.5 inch (approximately 6.5 cm) to prevent shrinkage cracks in the mortar.

ix. Storage / Shelf Life

Crystalline mortar shall be stored in a dry enclosed area off the ground at a minimum temperature of 45ºF (7ºC). Shelf life when stored in proper conditions in unopened, undamaged packaging is 12 months.

a. Guarantee for water proofing:

Work to be get executed through a approved specialized agency & covered by a 10 years guarantee by the main contractor against leakage, seepage and dampness etc. for which necessary performance guarantee for requisite indicated value of work shall be furnished by the contractor before completion.

b. Measurements:

The length and breadth shall be measured correct to cm. The flooring area shall be measured in sqm. Actual executed in raft slab. Inside wall surfaces of the basement upto ground level from top of raft slab shall be measured in sqm. Columns cross sections area not to be deducted from the plan area.

c. Rate:

Rates shall be inclusive of all operations including labour, material, T&P, scaffolding etc. complete. Nothing extra shall be payable on any account.

4. BRICK WORK
a. Bricks used in the work shall be obtained from kilns to be got approved from the Engineer in charge and shall be best quality well burnt ground moulded bricks as available in the vicinity. They shall have a compressive strength of not less than 75 Kgs/sq.cm and an absorption percentage of not more than 15 (Fifteen) % of its dry weight when immersed in water for 24 hours. In all other respects they shall conform to the provision in Latest CPWD Specifications for works.

b. Both the face of wall of thickness more than 23cm shall be kept in the proper plane. Walls of half brick thickness or less shall be measured separately and paid in sqm.

c. Bricks wall beyond half brick thickness shall be measured in multiple of half brick (i.e.115mm) which shall be deemed to be inclusive of mortar joints. In all other respects they shall conform to the provision in relevant specifications of the work.

5. WOOD WORK:

a. Timber required for manufacture of chowkhats and shutters for doors, windows, ventilators, partitions etc shall be Forest Stewardship council (FSC) certified wood and it shall be seasoned and preservative treated.

b. The moisture contents of the wood used in the work shall not be more than that stipulated in the relevant clause of Latest CPWD Specifications for works. The rate quoted for various items shall be inclusive of kiln seasoning and preservative treatment of wood. In all other respects the wood used in the work shall conform to the provision in latest CPWD specification for works.

c. The sample of species to be used shall be deposited by the contractor with the Engineer-in-charge before commencement of the work. The contractor shall produce cash voucher and certificate from standard kiln seasoning plant operator about the timber section to be used on the work having been kiln seasoned by them failing which it would not be so accepted as kiln seasoned.

d. Glass:–
   i. Transparent sheet glass (Float glass) conforming to IS 1761 – 1970 shall be used.
   ii. Minimum thickness shall be governed as under, unless otherwise specified in the item.

<table>
<thead>
<tr>
<th>AREA of Glazing</th>
<th>Max. Unsupported length</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>For Glazing Area Up To 0.5 Sqm</td>
<td>120 cm</td>
<td>4 mm</td>
</tr>
<tr>
<td>For Glazing Area More Than 0.5 Sqm</td>
<td>120 cm</td>
<td>5.5 mm</td>
</tr>
</tbody>
</table>

iii. Glazing for toilet and in fixed ventilators shall be of frosted type.

e. Shutters:-

i. Factory made shutters, as specified shall be obtained from factories to be approved by the Engineer – in - charge and shall conform to IS 2202 (Part –I) 1977. The contractor shall inform well in advance to the Engineer – in – charge the name address of the factory from where the contractor intends to get the shutters manufactured.
ii. The contractor will place order for manufacture of shutters only after written approval of Engineer – in – charge in this regard is obtained. The contractor is bound to abide by the decision of the Engineer – in-charge. In case the factory already proposed by the contractor is not found competent to manufacture quality shutters, the Engineer – in – charge will recommend the name of another factory from the approved list.

iii. The contractor will also arrange stage wise inspection of the shutters at factory with the Engineer in charge or his subordinate authorized representatives. Contractor will have no claim, if the shutters brought at site are rejected by the Engineer in charge in part or in full lot due to bad workmanship / quality or damages caused during their shifting from factory to site. Such shutters will not be measured and paid and the contractor shall remove the same from the site of work within 7 days after the written instruction in this regards are issued by the Engineer in charge or his authorized representatives.

6. **STEEL GRILL WORK:**
   a. All steel grills shall be according to the Architectural detailed drawings and obtained from approved suppliers. These shall conform to Latest CPWD Specifications for works.
   b. In case of grills an approved quality priming coat of zinc chromate shall be applied over and above a shop coat of primer. Nothing extra shall be payable for providing shop coat primer, but the zinc chromate primer will be paid for separately.
   c. The welded steel works shall be tested for quality of weld as laid in IS 822-1978 before actual erection.

7. **ALUMINIUM WORK:**
   a. The scope of the work is the fabrication, supply and erection at site of all types of Aluminium glazed doors, windows and ventilators in accordance with the drawings and specifications.
   b. The supply and erection will include all parts such as but not restricted to frames, tracks, guides, mullions, styles, rails, couplers, transoms, rails, plates glazing bars, glass, hinges, arrangement, spring catches, cord and pulley arrangements, spring catches, cord and pulley arrangements door closers floor springs etc., required for the whole work whether the parts/ items are individually and specifically referred to in the schedules/ specifications/drawings or not provided that the supply and installation of such parts can be inferred there from and are necessary to make the work complete, unless separate provision is made in the bills of quantities for supply to such parts/items.
   c. The doors, windows, ventilators, will be fabricated to suit the finished clear openings in the building/structure which the tenderer will himself measure.
   d. **Materials:-**
      i. The members will be made out of aluminium alloy corresponding to IS:733 and will consist of extruded sections and of other shapes, and to sized gauges as shown in the drawings/ described in accordance with the relevant IS codes. The members shall be chosen to provide strength/ stability and maximum resistance to wear and tear.
ii. The Sections will be as per approved makes, extruded sections. As indicated in the
drawings the tenderer should specifically mention which sections he is using.

iii. The weight of sections and the corresponding catalogue numbers are mentioned. The
IS specifications are to be strictly adhered.

iv. The alloy of extruded aluminium should be BS or IS old HE9, Alcon 50 SWP to this
effect test certificate has to be provided from the extruder.

e. Finishing:

i. The extruded aluminium section has to be mechanically finished to remove all
scratches; extrusion marks etc and subsequently thoroughly cleared in all alkali baths
prior to anodizing.

ii. The polyester powder coating, if required as per item of work, shall be of desired
shade with minimum average thickness to 50 microns or other shades as required and
to this effect the tenderer must have to produce test certificate from authorized
institutions Bureau of Indian Standard.

iii. The polyester powder coated material should be properly wrapped in gummed tape
before fabrication to avoid scratches during fabricated and erection shall be kept
protected till handing over.

f. Fabrication:

i. Before commencing the fabrication the contractor shall submit to the Engineer – in
charge for their approval detailed shop drawings, based on the Architectural drawings
and corresponding specification showing junctions, fittings, accessories such as hinges
flush bolts, locks, latches, latching arrangements, peg stays, rotor arms, anodize pivots
gaskets rubber packing door felts, mastic, sealant etc., including fixing and sealing
arrangements . Type and method of scaffolding he intends to use, Fabrication is to be
taken up only after approval by the Engineer – in - charge and in accordance with the
approved drawings. Sections for fabrication of door/ window/ventilators etc shall be
as per architectural drawings or as approved by the Engineer – in - charge.

ii. A sample of finished door / windows/ ventilator railing etc. shall be fabricated as per
the shop drawings approved by the Engineer – in - charge for final approval before
under taking mass production/ fabrication,

iii. The doors, window, ventilators and partitions shall as per thickness given in the BOQ
item / specifications, Polyester Powder coating shall be as specified in the item
specifications.

iv. All materials shall conform to relevant IS. Codes and in the absence of IS code, they
should correspond to the best engineering practice; decision of the Engineer – in
charge shall be final and binding on the contractor.

v. Fabrication shall be done true to the drawing/ sample approved and in
correspondence to the finished openings at the site. All joints shall be mitered at the
corners, true right angles, and joints to be finished neatly to hairlines, with concealed
fasteners, wherever possible joints shall be made in concealed locations.

vi. All fabricated/finished items shall be packed and carted properly to site to prevent any
damage in transit. On receipt at site they shall be carefully stacked in protected storage
to avoid distortion/damage.
vii. Site installation shall be with concealed screws, self-tapping or other approved fasteners or may be by welding, due precautions shall be taken to avoid any distortion/ discoloration /damage to the finished items.

eviii. Wood work faces /parts coming in contact with masonry shall before shifting to the site be given a heavy coat of alkali resistance bitumen paint. Steel items coming in contact with other incompatible materials shall be given a thick coat of zinc chromate primer.

g. Glazing: Glazing shall be done with flawless sheet glass of best approved quality without waviness, distortion, coloration / discoloration, of specified thickness in sizes as shown in the drawings, fixed as required with special glazing clips, putty, neoprene/PVC gaskets. All glass shall be cleaned thoroughly before they are fixed in position. Unless otherwise specified the minimum thickness shall be 5.5 mm thick.

8. **FIRE CHECK DOORS**:

a. **General**:

   i. The door shall be procured from approved manufacturer of CPWD / CBRI. The fire and smoke / hot gases check door shall be conforming to IS-3614 (Part-II)). The manufacturer shall have a prototype door tested and certified by CBRI Roorkee, of 120 min. fire rating confirming to BS : 476 part 22 & IS : 3614 Part II .

   ii. The fire and smoke / hot gases check door shall not collapse during the rated period of the fire under the specified fire conditions.

   iii. The fire and smoke / hot gases check door shall not allow the passage of hot gases or the flames through the rebate of the gap between the door frame and shutter or through the holes, developed in the shutter during fire.

   iv. **Material**: -Door frames and shutter shall be made from materials specified in the bill of quantities. In this work, wooden door frames and shutters are specified.

   v. **Shop drawing**: The contractor shall submit including required designing shop drawing for doorframes, shutters complete with

      a. Plan, elevation with relative position of adjacent works
      b. Glazing details with type size and fixing
      c. Fitting and fixtures with type size, brand and fixing details.
      d. Finishing details.

   vi. **Sample Approval**: A sample of fire check door including fittings and fixtures, shall be fabricated as per the shop drawings approved by the Engineer – in - charge for final approval before under taking mass production/ fabrication

b. **Fire Doors** : - These shall conform to the BOQ and CPWD specifications

9. **GLASS ENTRANCES AND GLAZING WITH PATCH FITTING**

a. **General**

   i. The contractor shall be responsible for design, fabrication, supply, installation, test and guarantee of all items including taking all measures that may be required to complete the work as per Architectural concept drawings and specifications details.
ii. The specialist agency engaged to carry out the external glazing installation and supply shall have at least 5 years of relevant experience and have completed external glazing systems of similar nature and equivalent scale of works as shown in the tender documents.

iii. The specialist contractor shall submit an outline of recent comparable works (illustrated by appropriate drawings, sketches, photographs, brochures) by the firm / its technical partner to illustrate the competence, experience and suitability of the firm.

b. The scope of work shall include:

i. Design, preparation of shop drawings, calculations, engineering data and test reports.

ii. Fabrication and installation of Glass Entrances and Glazing with Patch Fittings system.

iii. All anchors, fixings, attachments, reinforcements, steel reinforcing for mullions and transoms required for a complete installation, except those specifically indicated as being provided by other trades.

iv. Exposed Architectural mullions and other support members.

v. Finishes, protection coatings and treatments.

vi. Sealing with approved sealants within and around the perimeter.

vii. All thermal insulation, firesafing etc. including supports and/or backing.

viii. All caulking, sealing, electrometric and metal flashing, and gaskets including sealing at junctions with roof, ground-floor waterproofing and building expansion joints between structures.

ix. Electrical bonding and earthing of all metal cladding elements.

x. Provisions to receive electrical outlets and cutouts for conduits and other electrical work.

xi. Glass and glazing.

xii. Transportation, storage, handling, protection and cleaning.

c. Submittals

i. Product Data: Include construction details, material descriptions and dimensions of individual components, profiles and finishes.

ii. Shop Drawings

d. Fabrication and installation details, including followings

i. Plans, elevations and sections.

ii. Details of fittings and glazing.

iii. Hardware quantities, locations and installation requirements.

iv. Sample for verification, for each type of exposed finish required for

1. Metal finish: 150mm long section of patch fittings, rails and other items.
2. Glass: 150mm square, showing exposed edge finish.

e. Materials

i. Glass

1. Glass shall be as specified in drawing or BOQ or as per design requirement. It shall be Indian / imported hard coated reflective bronze and heat strengthened glass. It shall be of approved make.

2. In toughening of Glass, rolling direction shall be parallel to the width of the glass panel such that waviness if any is parallel to the horizontal and no waviness parallel to the vertical and to ensure that such waviness is of negligible order.

ii. Components

1. Patch fittings: Stainless steel clad aluminium

2. Floating Transom Bar: Steel cladded in metal matching fittings and in sizes recommended by manufacturer for application indicated. Include stainless steel support rods, lateral adjustment and ceiling channel. Support fins to be metal, finished to match transom bar.


4. Accessory Fittings: Matching with patch fittings and rails metal and finish for overhead door stop, Centre hoseing lock, glass support fin brackets and other as shown in drawing.

5. Anchors and fastenings: Concealed

6. Weather stripping: Sweep type

iii. Hardware

1. Hardware should be heavy duty in matching finish

2. Concealed Floor Closer and Top Pivots
   a. Centre hung; BHMA A156.4, Grade 1; including cases, bottom arm, top walking beam pivots, plates, and accessories required for complete installation.
   b. Swing: Double acting; Positive dead stop, concealed with hold open angle
   c. Delayed action closing
   d. Concealed Overhead Holder: Grade 1, with dead stop setting coordinated with concealed floor closer.
   e. Push-pull set: Stainless steel finish

3. Lock set of approved make.

f. Fabrication

1. Provide holes and cut-outs in glass to receive hardware, fittings, rails and accessories before tampering glass. Fully temper glass using horizontal (roller-hearth) process and fabricate so, when installed, roll wave distortion is parallel with bottom edge of door or tile.

2. Factory assembled components and factory installed hardware to greatest extent possible.
g. Execution

1. Examine areas and condition for compliance with requirements for installation tolerances and other conditions affecting performance of work.

2. Install all glass system and associated components according to manufacturer’s written instructions.

3. Set units in level and plumb.

4. Maintain uniform clearances between adjacent components.

5. Lubricate hardware and other moving parts according to manufacturer’s written instructions.

6. Set, seal and grout floor closer cases as required suiting hardware and substrate indicated.

h. Cleaning

1. The Contractor shall ensure that all actions are taken during installation to eliminate the effects of corrosive substances on the finishes.

2. The Contractor shall clean both internal and external surfaces to remove corrosive substances, dust or cement / mortar dropping during the installation as may be directed and instructed by the Engineer – in - charge.

3. The internal surfaces of glass and aluminium frame are to be cleaned with compatible cleaning agents prior to the installation of the internal protective sheeting.

4. The Contractor shall provide written verification that cleaning agents are compatible with aluminium, stainless steel, glass coatings, granite, glazing materials and sealants. In no case shall alkaline or abrasive agent be used to clean the surface. Care shall be taken during cleaning to avoid scratching of the surface by grit particles.

5. Prior to snagging inspections the Contractor shall, remove the internal protection sheets and carry out a thorough cleaning of all glass and aluminium.

6. The Contractor shall also make good any physical damage to the structure including scratches, dents, abrasions, pitting, etc. to the satisfaction of the Engineer – in - charge.

7. Manufacturer’s delivery or job markings on glass and adhesive for manufacturer’s labels shall be either a neutral or slightly acidic material. In no case shall such material be alkaline; any staining of glass by alkaline material will be cause for rejection of the glass.

8. After the installation of each pane of glass all markings and labels shall be carefully and completely removed from the panes. Thereafter no markings or labels of any sort shall be placed on the glass.

9. Glazed openings shall be identified by suitable warning tapes or flags attached with a non-staining adhesive or other suitable means to the framing of the opening. Tapes or flags shall not be in contact with glass.

10. As soon as it is practically possible after the issuance of the occupation Permit for the Building, the Contractor is to carry out a complete cleaning of the external face.
**i. Performance Guarantee:** The contractor shall offer a minimum of 10 year Performance Warranty for the entire installation carried out.

**j. Measurements:** Measurements shall be in Sqm. of actual area covered.

**k. Rate:** Rate shall include all required labour, material, designing, drawing conveyance, testing at approved laboratory breakage, wastage, supervision, protection till hand over and free maintenance during defect liability period etc. complete.

10. **FLOORING:**

   a. The flooring in the building shall be as per the approved floor finish drawings and laid in such a way that limits in floor levels would not exceed the limits provided in the latest CPWD specifications or manufactures specifications.

   b. Wherever Vitrified Tile flooring is done, it shall be with multi grade/range 1st Quality tiles.

   c. Slope in floors shall be provided as per architectural drawings, else the levels at any place when checked over a distance of one meters in any direction should not show variation in floor level more than 3 mm.

   d. Rate for the items of flooring is inclusive of provision of sunken flooring and finishing edges of the same in bath kitchen, toilets, cutting holes for traps/ pipes etc., and nothing extra shall be paid on this account unless otherwise specified.

11. **FALSE CEILING:** False ceiling items in general are carried out as per the description of the item in the Bill of quantities and also as per the manufacturer’s specifications / CPWD Specifications / as directed by the Engineer – in – Charge. Location of particular type of false ceiling shall be as per relevant drawing, in its absence written approval of the Engineer – in - charge shall be obtained.

12. **ALUMINIUM COMPOSITE PANELS (ACP) CLADDING**

   a. Scope of Work includes providing and fixing Aluminium Composite panel cladding including framing as per the elevation, section and the plan drawings provided, fabricated out of heavy duty Aluminium extruded profiles conforming to alloy 643900 WP with chemical composition and mechanical properties as per IS-733 and as per specifications. The scope of work shall be read in conjunction with the specification of curtain walling / structural Glazing System.

   b. The contractor shall design, supply, fabricate, deliver and install and guarantee all construction necessary to provide a complete aluminium composite panel cladding, complete with all necessary anchors, hardware and fittings to provide a total installation, fully in conformity with the requirements and intent of the drawing and specification as per item description. Wherever required Spandrel panels to be provided as per direction of Engineer in charge.

   c. The contractor shall design the cladding as per the prevalent site conditions and building elevations profiles. The design parameters shall be in conformity the structural glazing system. No extra claims shall be entertained at any stage for
aluminium profile/ wall thickness and size dimensions. The Contractor must quote rates accordingly.

d. The anchoring / bracing of the wall cladding to the RCC beams/ columns shall be done with non-corrosive galvanized brackets of approved design, (Galvanizing to be done conforming to IS 4759-1996 up to 610 gms. Per Sq. M. (80-90 micron thickness).

e. The framework shall be aligned for the entire height of each Mullion and of the entire width of each Transform by laser beam equipment to ensure 100 percent ‘X’ axis and ‘Y’ axis alignment.

f. The system should also provide for pressure equalization. The details for pressure equalization to be submitted by the contractor and got approved by the Engineer-in-charge.

g. EPDM Gaskets of suitable profiles (to accommodate shall be provided including the labour element for fixing in appropriate locations is to be included in the rate).

h. The Periphery of the framework shall be sealed both from inside and outside with silicon weather sealant to make the cladding watertight.

i. Cost of Aluminium composite panel consisting of a core of polyethylene sandwiched between two aluminium skins of 0.5mm thickness with a mild edge. 4 mm total thickness with surface finish of PVDF coating as approved by the Engineer-in-charge, as shown in the elevation, plan and cross section drawings along with labour element for cutting stacking, carrying to heights and fixing to appropriate locations is included in the rates.

j. All the vertical and horizontal section grooves are to be sealed non staining silicon sealant of make as specified in the list of approved make to make the entire system synchronies with the basic structural glazing/curtain wall structure and also make the system air tight and watertight. The fixing details should be got approved by the Engineer-in-charge. The peel off foil should be removed at the time of handing over as may be required by the Engineer-in-charge.

k. Any joint provided between cladding elements to cater for individual panel installation and shall be sealed off with extruded EPDM gasket or silicon sealant.

l. **Product**
   i. ACP shall be as approved with high fibre filled sandwiched panel 4mm install on Aluminium framing and Galvanized brackets. Aluminium cladding panel to be PVDF fluorocarbon coated factory applied colours. Reverse side to be in mill finish. All the joints shall be sealed with silicon sealant of approved make. The colour of sealant to be decided by Engineer-in-Charge.
   ii. A sample of panels and installation methods to be submitted to the Engineer-in-Charge for approval.

m. **Manufacture**
The panels must be visually flat. Any stiffener applied to compensate for wind load must not read through.

n. **Installation**
The panels shall be fixed in accordance with manufacture’s recommendations.
### Technical Properties of Aluminium Composite Panels

<table>
<thead>
<tr>
<th></th>
<th>Composition</th>
<th>4.0 mm thick aluminium composite panel comprising of 3mm thick Fire Retardant mineral filled Core comprising of around 70% Inorganic compound which is 100% non-combustible mineral and balance 30% is food grade virgin polymer sandwiched between two Aluminium sheets (each 0.5 mm thick).</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Dimensions</td>
<td>Panel thickness: 4mm</td>
</tr>
</tbody>
</table>
| C | Tolerance | Width ± 2.0mm  
Length ± 4.0mm  
Thickness ± 0.02mm |
| D | Principal Properties | Panel weight: 5.5 kg/sq.m  
Thermal expansion: 1mm/M/60deg.C.  
Moment of Inertia: 0.347 cm$^4$/m |
| E | Acoustic Properties | Average airborne sound transmission loss R/N 25db (DIN 4109) |
| F | Mechanical Properties | Tensile strength ≥130 N / mm$^2$  
0.2 % proof stress 90 N / mm$^2$  
Elongation 5%  
Modules of elasticity 70,000 N/mm$^2$ |
| G | Thermal Transmittance | R = 0.014 m$^2$ °C/W |

---

**Fire Rating and other ratings**
ACP must furnish Class 1A certificate of conformity. Fire Retardant (FR) panel must conforms to FST (ISO 5658-2 & ISO 5659-2) properties, as per EN 45545: Hazard level-3 and also conforms to BS 6853 fire testing. The ACP sheet shall be coil coated with Kynar 500 based (70:30 ratio) PVDF / Lumiflon based fluoropolymer resin coating of approved colour and shade on face # 1 “specification for coated coil for the exterior building application” issued by ECCA (European Coil Coating Association). The coating shall confirm to AMMA-2605 for superior performing of exterior grade finish and polymer (Service) coating.

**Finish**
PVDF stove lacquered (Fluoro carbon) on one side and reverse side in mill finish.

**Colour**
Colour to be selected by Engineer-in-Charge using standard PVDF colour chart from manufacturer.

**Panel size:**
- Width: 1000 / 1250 / 1500mm

**Length**
- 1500 and 5000mm

**Aluminium Extrusions**
Extrusions shall be of aluminium alloy 6063 T5, conforming to BS-1470 – 1475: 1972 in mill finish.

---

**Protection:** The finished surface shall be protected with 80 microns self-adhesive Peel Off film with two layers of white and black tested to withstand at least 6 months exposure to local weather condition, without losing the original peel off
characteristic or causing stains or other damages. Protection should not be removed until after installation.

q. **Warranties:** The Contractor shall provide a data to confirm compliance with specific requirements for resistance and fire properties. The guarantee should be for a 20 salt spray resistance and fire properties. The guarantee should be for a 20 year period against peeling chalking (No. 8 rating), fading, blistering, flaking, chipping and cracking.

r. **Measurement:** The measurement shall be for exposed actual surface area with grooves cladded on plain/ curved surface excluding the concealed trims.

s. **Technical Data:** The technical data provided hereunder is for guidelines. The data, specific for the site location, shall be got approved by the contractor from the Client/ Engineer-in-Charge for the design of the ACP and structural Glazing System.

i. **Design Wind Loading**
   - 850 N/m² positive and negative to Podium.
   - 1150 N/m² positive and negative to Tower.
   - 1500 N/m² positive and negative to Crown to Tower.

No cladding element shall sustain permanent deformation of failure under loading equivalent 1.5 times the design wind pressure specified.

ii. **Deflection**

   Deflection of any aluminium frame shall not exceed 1/175 of the clear span.

iii. **Expansion and Contraction**

   The cladding shall be so fabricated and erected as to provide for all expansion and contraction of the components. Any temperature change due to climatic conditions shall not cause harmful buckling, opening of joints, undue stress on fastening and anchors, noise of any kind or other defects.

iv. **Flatness**

   The cladding surface taken individually shall not have any irregularities such as oil canning, waves, buckles and other imperfections when viewed at any position but not less than at an angle of 15 degrees to the true plane of the panel with natural lighting of incident of not less than the same angle.

v. **Water Tightness**

   The panel cladding shall be so constructed to be water tight with provision for rear ventilation.

vi. **Acoustic Treatment**

   The cladding panel system shall be designed so as to dampen noise caused by splashing water.

a. **Fixings**

i. Fasteners including concealed screws, nuts, bolts and other items required for connecting aluminium to aluminium shall be of non-magnetic stainless steel.
ii. Rivets used for fastening panel to aluminium sub-frame shall be of alloy aluminium large flange head type with stainless steel mandrel.

iii. All fixing anchors, brackets and similar attachments used in the erection shall be of aluminium or non-magnetic stainless steel.

b. Weather seal

i. All exposed joints between panels which are required to be water tight, shall be sealed with extruded EPDM gasket of hardness approx. 75 SHORE.

ii. All secondary weather seal shall be of self-adhesive tape as approved by the Engineer-in-charge.

13. STRUCTURAL GLAZING SYSTEM

a. Scope Of Work

i. The contractor shall design, engineer, test, fabricate, deliver, install, and guarantee all construction necessary to provide a complete structural glazing system to the proposed building, all in conformity with the Drawings as shown. Specification and all relevant construction regulations including providing any measures that may be required to that end, notwithstanding any omissions or inadequacies of the Drawings and/or without limiting the generalities of the foregoing, the structural glazing Systems shall include, without being limited to, the followings:

- Metal frames, glass glazing, spandrels, ventilators, finish hardware, copings metal closure, windows etc.
- All anchors, attachments, reinforcement and steel reinforcing for the systems required for the complete installations.
- All thermal insulation associated with the system. All fire protection associated with the system.
- All copings, end closure and metal cladding to complete the system.
- All sealing and flushing including sealing at junctions with other trades to achieve complete water tightness in the system.
- Isolation of dissimilar metals and moving parts.
- Anticorrosive treatment on all metals used in the system. Polyester powder coating aluminium sections.

ii. The contractor shall also be responsible for providing the followings:

- Engineering Proposals, Shop Drawings, Engineering data and Structural Calculations in connection with the design of the structural glazing System.
- Scheduling and Monitoring of the Work.
- Mock-ups, samples and test units.
- Performance testing of the structural glazing framing and glazing assembly.
- Co-ordination with work of other trades.
• Protection.
• All final exterior and interior cleaning and finishing of the structural glazing System
• As-built record drawings and photographs.
• Guarantees and Warranties.
• All hoisting, staging and temporary services.
• Conceptualizing and design of a suitable maintenance system for structural glazing.

iii. The water tightness and structural stability of the whole structural glazing System are the prime responsibility of the Contractor. Any defect or leakage found within the Guarantee Period shall be sealed and made good all at the expense of the Contractor.

iv. The structural glazing system shall be designed to provide for expansion and contraction of components which will be caused by an ambient temperature range without causing buckling, stress on glass, failure of joint sealants, undue stress on structural elements or other detrimental effects. Specific details should be designed to accommodate thermal and building movements.

b. Building Regulations

Structural glazing shall comply with all Government Codes and Regulations including IS codes, if any.

All structural glazing; individual aluminium and glass components and all completed work shall be designed and erected to comply with the following:

i. Design load and deflection.

ii. Structural glazing construction in its entirety shall be fabricated and erected to withstand without damage or permanent deformation inward (positive) and outwards (negative) pressure, all acting normal to the construction plane with a maximum deflection of not exceeding 1/175 of the clear span between structural support or 20mm maximum whichever is less.

iii. Structural performance of all parts of structural glazing system shall conform to relevant IS codes, wind load as per IS-875 and seismic loads as per IS-1893. Deflection shall cause no permanent set in excess of 1/1000 of span nor evidence of structure failure.

iv. Design Wind Loading

• 850 N/m² positive and negative to Podium.
• 1150 N/m² positive and negative to Tower.
• 1500 N/m² positive and negative to Crown to Tower.

No cladding element shall sustain permanent deformation of failure under loading equivalent 1.5 times the design wind pressure specified.

c. Measurements

Measurements of the structural glazing shall be in the metric system in sq.m correct to two places of decimal. The area considered for measurement shall be net area as
fixed on the exterior face of the structural glazing including open able windows as part of structural glazing. The contractor shall be responsible for verifying all the dimensions and actual conditions on site.

d. Rate
The rates shall include the cost of all the operations described above including the cost of all materials, labour, design, fabrication, erection, finishing, scaffolding and testing of water tightness etc.

e. Tender Drawings and Specifications
The tender drawings indicate profile and configuration required together with relationship to structural frame and interior building elements.

The Specification and tender drawings is of the performance type and includes only the minimum requirements of the /structural glazing Wall System without limiting the Contractor to the method of achieving desired performance.

f. Post Tender Requirements
i. Design Proposals
The contractor shall propose the final design in such a way that all basic functional and architectural requirements are fulfilled and get the same approved by department. However, basic design requirements as described in the specification and other Architectural requirements such as the size of window, net glass area, ventilator, configuration of windows and spandrels shall be retained.

The design proposals shall be in the form of drawings, drawn to full scale as far as practical and specification shown in or describing all items of work including:

- Request details as indicated on the tender drawings.
- Metal quality, finishes and thickness.
- Glass quality, coating and thickness and proposed manufacturer’s brand names.
- Sections of the mullion and transom together with structural calculations.
- Arrangement and jointing of components.
- Field connections especially mullion to mullion and transom to mullion.
- Fixing and anchorage system of typical wall unit together with structural calculations.
- Drainage system and provision in respect of water leakage in the curtain wall/structural glazing system.
- Provisions for thermal movements.
- Sealant and sealing method.
- Glazing method.
- Wind load and seismic load and any other specific load considered in the design.
- Lightning protection link-up system of the curtain wall/structural glazing for connection and incorporation into the lightning conductor system of the building.
Design concept must be stated in the proposal.

The maximum permissible structural tolerances of the building that the system has been designed to accommodate in case this tolerance exceed those specified in the Specification.

Any parts of the curtain wall/structural glazing, when completed, shall be within the following tolerances:

- Deviation from plumb, level or dimensioned angle must not exceed 3mm per 3.5m of length of any member, or 6mm in any total run in any line.
- Deviation from theoretical position on plan or elevation, including deviation from plumb, level or dimensioned angle, must not exceed 9mm total at any location.
- Change in deviation must not exceed 3mm for any 3.5m run in any direction.

**ii. Samples**

The contractor shall also submit samples of mullion and transom sections in lengths of 300mm with the same finish and workmanship along with the proposals and 300mmx300mm samples of glass (samples to include exposed screws and other exposed securing devices, if any).

**iii. Preliminary Programme**

The tenderer shall also submit a preliminary programme of the contract works showing the various stages of design sampling, testing, fabrication, delivery and installation of the works.

**iv. Upon approval of the shop drawings, at least 4 copies shall be submitted by the Contractor.**

**v. The Contractor/Sub-contractor shall submit a maintenance manual for the curtain wall/structural glazing system inclusive of all metal parts, glass and finish etc.**

**vi. During detailed design and execution any details may increase as per actual requirement at site, these variations shall be executed without any extra cost implications to the client.**

**g. Execution:- Performance Testing**

The performance tests are to be conducted on the structural glazing system, if the area of the structural glazing system exceeds 2500 Sq.ms from the certified laboratories accredited by NABL (National Accreditation Board for Testing and Calibration Laboratories), Department of Science and Technology, India. The decision of the Client/Engineer-in-charge about the necessity of testing of shall be final and binding.

**i. General Requirements**

Mock-up units shall be constructed by the contractor and tested to determine the structural stability as well as air and water infiltration or leakage at glazing beads and all other joints designed into the façade.

After approval of structural calculations and shop drawings for the structural glazing, one (1) Test Unit for performance testing of the structural glazing shall be
constructed by the contractor at a laboratory approved by the Department (Refer BOQ).

Erect mock-up under manufacturer's/installer's direct supervision and employ workmen as they would be employed during the actual erection at the job site.

Test procedures test schedules and test locations shall be submitted to Client for approval before testing.

Prior to fabrication of Test Units, the contractor shall submit shop drawings and calculations of the Test Unit for the Engineer-in-Charge's approval.

Production for final job site erection shall not start until approval has been obtained as a result of the mock-up test.

ii. Test of Wind Pressure

The equivalent load of wind pressure or wind suction shall be given to the Test Unit as increasing or decreasing the inside pressure in the ‘Pressure Chamber’ at which the Test Unit is fixed.

The static wind pressure shall be applied up to 1.5 Kpa at maximum wind pressure. The variation of dynamic pressure shall be of any approximate sine-cure-line.

Deflection on each observational points of the Test Unit shall be observed and recorded under the Static pressure as described above.

Any damage and harmful permanent deformation on any parts except sealing materials shall not be found at maximum wind pressure.

The deflection on the main structural parts in these conditions shall not exceed:

1/175 of the span between supports or 20mm, whichever is the lesser for vertical elements.

1/250 of the span between supports for horizontal elements.

The extent of recovery of deformation 15 minutes after the removal of the test load is to be least 95%.

iii. Test of Lateral Deflection Per Floor Height

Lateral deflection per floor height shall be occurred on the test unit, when the structural frame which fixes the test unit is deflected horizontally.

The deflection of every + 2.5mm shall be increased upto + 13mmm on the Test Unit (Static Deflection Test).

The dynamic deflection shall be applied upto + 13mm.

The variation of dynamic deflection shall be of an approximate sine-curve-line, one period of 3 seconds.

The dimension of the deflection on each observational points of the Test Unit shall be measured under the condition as described above, the damage shall be observed.

Any damage and harmful permanent deformation shall not be found in any parts of the curtain wall/structural glazing except sealant at maximum deflection.
iv. **Test of Water-tightness**

Water shall be sprinkled to the Test Unit under the wind pressure. Pressure shall not be applied to the Test Unit.

The volume of the sprinkling water in one minute shall be 5 liters/m² min. (0.1 gal/ Sqft).

All water leakage and drainage system at the joint and open able sash of the curtain wall/structural glazing system shall be observed from the outside of the chamber.

Hold the test 2 times, in sequence as described below, conforming to the above mentioned conditions.

Install the test unit.

Hold 1st water-tightness test.

Hold test of wind pressure as described above. Host 2nd water-tightness test.

Lateral deflection test.

Water leakage at all parts of the Test Unit shall not be observed inside during the 1st water-tightness test.

v. **Test Report**

The Contractor is required to submit five (5) copies of test reports to the Client.

vi. **Cost of Performance Test**

The Contractor shall allow in his tender for the cost of the performance testing and of fabrication, erection, corrections to and demolition of the Test Units including any special provision required in the testing laboratory for the tests mentioned above.

The Contractor shall allow for amendments and adjustments to the mock-up as required by the Employer.

If the Test Unit fails to pass the initial testing, the Contractor shall make the necessary corrections to the Test Unit and shall have to get the Test Unit retested by the Testing Laboratory till it passes the tests.

Cost of corrections to the Test Unit and cost of re-testing shall be borne by the Contractor at no additional cost to the Employer.

vii. **Shop Drawings and Calculations for the Performance Testing**

Prior to fabrication of Test Unit, the Contractor shall submit shop drawings and calculations of the Test Unit for Client/employer’s approval.

viii. **Record Drawings**

The testing laboratory shall keep copy of approved Test Unit shop drawings and calculations at testing laboratory during testing of Test Unit.

The testing laboratory shall accurately and neatly record on the above mentioned shop drawings all changes, revisions, modification etc. made to Test Unit, which shall become the record drawings.

At completion of testing and after approval of test reports the testing laboratory shall submit the marked-up record drawings to the Client.
ix. **Contractor’s Representatives**

Full time attendance by Approved Representatives of the Contractor & subcontractor associated with the erection of curtain wall/structural glazing shall be provided for the erection of the Test Unit and for all testing of the Test Unit.

**h. Performance Guarantee**

The tendered shall provide a performance guarantee of requisite value to be indicated in the General Conditions of Contract for a period of five years, to provide for expenses, to cover the risk and cost of rectification of defect, noticed during the five years guarantee period. Guarantee period to start from the date of completion of the project.

**14. STAINLESS STEEL RAILINGS**

a. The scope of the work includes preparation of the shop drawings (based on the architectural drawings), fabrication, supply, installation and protection of the stainless steel railing till completion and handing over of the work.

b. The stainless steel work shall be got executed through specialized fabricator having experience of similar works. The Contractor shall submit the credentials of the fabricator for the approval of the Engineer-in-Charge.

c. The Contractor shall submit shop drawings, for approval of the Engineer-in-Charge, for fabricating stainless steel railing with detailing of M.S. stiffener frame work backing along with the fixing details of the M.S. frame work to the R.C.C columns. The details of the joints in the stainless steel railing including location, etc. shall also be shown in the shop drawings.

d. The Contractor shall procure and submit to the Engineer-in-Charge, samples of various materials for the railing work, for approval. After approval of samples, the Contractor shall prepare a mock up for approval of Engineer-in-Charge / Consultant. The material shall be procured and the mass work taken up only after the approval of the mock up by the Engineer-in-Charge / Consultant. The mock-up shall be dismantled and removed by the contractor as per the directions of the Engineer-in-Charge. Nothing extra shall be payable on this account.

e. The stainless steel shall be of grade 304 with brushed steel satin finish and procured from the approved manufacturer. It shall be without any dents, waviness, scratches, stains etc.

f. The required joints in the railing provided as per the architectural drawings, shall be welded in a workmanlike manner including grinding, polishing, buffing etc. all complete and compacted. The temporary clamps provided and fixed to hold the stainless steel railing, in position shall be removed after the concrete has set properly. The junction of the flooring and the cladding shall be neatly filled with weather silicone sealant of approved colour and shade. Nothing extra shall be payable on this account.

g. One test (three specimens) for each lot shall be conducted for the stainless steel pipe in the approved laboratory. Therefore, the material shall preferably be procured in one lot from one manufacturer.
h. The finished surface shall be free of any defects like dents, waviness, scratches, stains etc. and shall have uniform brushed steel satin finish. Any defective work shall be rejected and redone by the Contractor at his own cost. The finished surface shall therefore be protected using protective tape which shall be removed at the time of completion of the work. The surface shall then be suitably cleaned using nonabrasive approved cleaner for the material. Nothing extra shall be payable on this account.

i. The item includes the cost of all inputs of labour, materials (including stainless steel pipes, welding, brazing, concrete, protective film, weather silicone sealant etc including cost of providing and fixing M.S. frames), T & P other incidental charges, wastages etc. The items also included providing and fixing stainless steel anchor fasteners for fixing railing.

j. The railing shall be fixed in position using stainless steel pipes, stainless steel posts of required diameters and thickness as shown on drawing and polished to satin finish including cutting, welding, grinding, bending to required profile and shape, hoisting, butting, polishing etc.

k. The item includes the cost of all inputs of labour, materials, T&P, other incidental charges, wastage etc. The entire work shall be carried out to the satisfaction of Engineer-In-Charge.

15. GLASS:

a. All glass and glazing material shall be verified and coordinate with the applicable Performance requirement.

b. All glass shall be cut to require size and ready for glazing. All glass shall be accurate sizes with clear undamaged edges and surfaces which are not disfigured. Any panel which does not fit any section of the curtain wall and shop front will be rejected and a replacement made at the Contractor's expense.

c. Glass shall conform to the quality, thickness and dimensional requirement specified in US Federal specifications DD – G0415C.

d. Heat strengthened glass shall not deviate in surface flatness by more than 0.23 mm within 260mm of leading or trailing edge, or 0.076mm in centre. Direction of ripple shall be consistent and is acceptable to Engineer-in-Charge. Distortion of glass shall be controlled as much as possible during heat strengthening. Sag distortion shall be unidirectional and surface compression shall be in the range of 320-450 Kg/cm². All glass shall be delivered to site with the manufacturer’s label of identification attached.

e. The glass glazed panel / structural glazing frames for the structural glazing system shall be designed to withstand lateral imposed loads and comply with requirement of local building codes.

f. Glass shall be free from defect or impurities detrimental to its performance. Defects such as bubbles, waves, spots scratches, spalls, discoloration, visibly imperfect coating, chipping, and bubbles delaminating of opacifier film shall be limited in accordance with the Manufacturer’s / trade guidelines. The glass is to be produced in such a way that the rollers will be parallel to what will be the horizontal position of the glass. Glass should be consistent in colour.
g. Double glazed units shall be procured only from approved manufacturer. Quality control tests shall be performed for mixing, curing, adhesion and dew point. The unit shall be guaranteed against condensation and dirt between the panes, failure of seal and damage to internal coating.

h. All glass breakage caused by the Contractor or his sub-contractor because of negligence or caused by the installation of faulty work by him shall be replaced by the Contractor at his own expense without delay to the project completion.

16. CLEAN ROOM PARTITIONS

a. Wall panels (80mm thick)

i. The Wall panel shall be double skin type, 80 mm thick, sandwiched with self-extinguishing quality PUF of density not less than 40±2 kg/cum. The inner and outer skin shall be of powder coated steel sheet, the thickness of inner skin and outer skin of the panel shall not less than 0.8mm GPSP GI Sheet with epoxy polyester powder coating both side of the panel shall be smooth finished and both side of the panel shall be off- white colour, the coating thickness shall be not less than 80 microns including the primer and finished coat, the panels shall be covered with peel off film to ensure that the material is protected against scratches and indentation during transit and storage. The Panels are designed to have a flush finish with coved corners for easy cleaning.

ii. The wall panels shall have a recessed male edge on one side and roll formed female edge on the other side, which creates an interlock, thus ensuring panel finished and snug insulation to insulation fit. All the wall joints shall be filled with suitable length as required in a continuous length lamination. All the wall joints shall be filled with suitable sealant material.

iii. Suitable reinforcement shall be provided between the panels from the floor to ceiling wherever the room doors are shown in the drawing.

iv. Clean room walls shall have view windows of size not less than 900mm width X 1100mm height placed at 1000mm above the ground level on the wall panel of the modular clean room and these double glass view windows shall have toughened glass panels of thickness not less than 5mm and all the joints between toughened glass and wall panels shall be sealed. These view windows (glazed) shall be covered with yellow films.

v. Wall panels shall be fixed with necessary bottom floor track and top runner 'U' channels, anchor fasteners screw etc., for fixing the door suitable 'L' and 'C' sections shall be used. All the wall joints shall be filled with suitable sealant for effective sealing.

vi. Suitable Coving of Radius 50 mm made out of anodized Aluminium material shall be fixed along the joints between wall & the Floor, wall & the false ceiling joints between the Wall panels, 3D covings at the Corners as required.

vii. The wall panels shall be embedded with conduits for wiring and utilities etc., wherever required. The panels shall be offered for inspection for Site Engineers during fabrication at manufacturing works if required. The supplier shall furnish test certificate indicating the values of epoxy polyester coating coverage, powder coating...
thickness, material of inner and outer skin, thickness of inner and outer skin etc., as applicable for panels.

b. Ceiling Panels

i. Ceiling panel shall be double skin type, 44 mm thick, sandwiched with self-extinguishing quality PUF of density not less than 40±2 kg / cum. The inner and outer skin shall be of power coated steel sheet, the thickness of inner skin and outer skin of the panel shall not less than 0.8mm the powder coated GPSP GI sheet shall be hot dip galvanized with epoxy polyester powder coating not less than 180 gm / sq m both side of the panel shall be smooth finished and both side of the panel shall be off white color, the coating thickness shall not be less than 50 microns including the primer and finished coat, the panels shall be covered with peel off film to ensure that the material is protected against scratches and indentation during transit and storage.

ii. The Ceiling panels shall have a recessed male edge on one side and roll formed female edge on the other side, which creates and interlock, thus ensuring panel finished and snug insulation to insulation fit. All the wall joints shall be filled with suitable length as required in a continuous length lamination.

iii. Necessary services/trap doors shall be provided to the false ceiling for maintenance on the top of the false ceiling.

iv. All the joints and corners between ceiling and wall panels, wall panels and wall panels, wall panel to floor of modular clean room shall be provided with Aluminium R 50 coving same panel finish and color.

v. The panels shall be offered for inspection for Site Engineers during fabrication at manufacturing works.

vi. The suppliers shall furnish test certificate indicating the values of epoxy polyester powder coating thickness, materials of inner and outer skin, thickness of inner and outer skin etc., as applicable for panels.

c. Cut out in Wall panel and Ceiling panel

i. Cut-outs wherever required shall be provided in the wall panel/ceiling panel as applicable for fan filter units, terminal HEPA filters, light fixture, return air grills, power sockets, communication outlets, LAN outlets, cables, pipes, exhaust ducts, gauges, smoke sensors, pendants, utilities, etc, as required.

ii. All cut-outs made in the wall panel and ceiling shall be finished properly as required for clean room environment.

d. Clean Room Doors

i. Flush door, roller hinged type single leaf shall be fabricated out of similar material to wall panels as mentioned in the tender specification above, the size of the single door shall be 900mm x 2100 & Double Doors shall be 1500 mm X 2100 mm, single leaf emergency door shall be 900 x 2100mm clear size measured inner to inner of frames, subject to site requirements.

ii. The view window of size 900mm width x 1100mm height placed at 1000mm above floor, subject to site requirements, shall have 5mm thick double glass duly fixed and sealed to the door panels. The door shall be provided with door closer and lock. The door
handles, push plate and hinges shall be of stainless steel. The thickness of door shall not be less than 44 mm.

iii. Nothing extra is payable for change in size of door/ windows as per site requirements.

e. **Clean Room Emergency Doors**

i. Flush door, roller hinged type single leaf shall be fabricated out of similar material to wall panels as mentioned in the tender specification above, the size of the single door shall be 900mm x 2100 & Double Doors shall be 1500 mm X 2100 mm, single leaf emergency door shall be 900 x 2100mm clear size measured inner to inner of frames, subject to site requirements.

ii. Nothing extra is payable for change in size of door/ windows as per site requirements.

17. **Flooring for Microbiology Lab**

Heavy duty colored Epoxy flooring, complying with flooring requirements as per Good Laboratory Practices norms as detailed as per specifications in the Bill of Quantity.

18. **Antibacterial Paint**

a. The Antibacterial Paint shall be able to provide anti-Microbial Protection:

b. The scope of work includes providing & applying approved makes anti-Microbial Paint on wall surfaces as per manufacturer’s specifications complete in all respect & as directed by Engineer-in-charge. Following are the desired characteristic of the paint:

i. Protection: The product hygiene coatings to start the biocidal action as soon as the microorganism land on the surface, and prevents the growth of mould, bacteria and yeasts for at least 5 years.

ii. Lily Cycle Savings: The unparalleled durability of hygiene coatings should help to extend the maintenance cycle and to minimize all related material, labour and shut down costs.

iii. Chemical Persistence: The hygiene coatings should be highly resistant to abrasives, detergents and weak acids and alkalis used in cleaning regimes. Furthermore, they can be regularly steam cleaned without any loss of performance or adhesion to the substrate.

19. **BORE WELL**

a. **Scope of Work**

The general character and the scope of work to be carried out under this contract are illustrated in the following specifications. It gives only general guidance as regards design, drilling and construction of tube wells. Before selecting the method of construction to be adopted, the contractor shall give due consideration to site condition and Geological data of the site. The construction and testing of tubewells shall be as per IS 2800- 1979 (Part 1 and 2). This contract is an item rate contract. All payments shall be made for the actual work executed. The Contractor shall ensure the required minimum yield.
b. Selection of Site
The site where the tubewell is proposed shall be examined by tenderer, and changes if required shall be discussed with the engineer prior to start of work. Any previous data available with the Contractor regarding nearby tubewells should be made use of to evolve suitable procedure for drilling, developing, testing etc.

c. Geological Data
During the drilling operation, contractor shall collect the samples of different strata from suitable intervals or where change in strata is met with. It shall be carefully examined and analyzed and the data shall be preserved carefully and handed over to Engineer. The contractor shall make one drilling time log during the execution of work for the bore well.

d. Design and lowering of pipe assembly
The length and diameter of the housing pipe shall be selected on the basis of static water level, the draw down and the discharge expected from the well and the size of the pump to be installed. The size and length of blind pipes and the slotted/strainer pipes shall be selected according to the expected discharge and the depth of tubewell. The size and distribution of the slots shall be as per IS 8110. After completion of the bore hole the contractor shall assemble the tube well assembly according to the water bearing strata met during boring, after getting the same approved from the Engineer and shall lower in to the drilled hole the same keeping the slotted strainer opposite to water bearing strata from which the water is to be extracted. The bail plug shall rest on firm ground. Before the bail plug is lowered, about one metre depth of the bore hole shall be packed with the gravel to avoid sinking of the assembly. In case part of a bore hole is not proposed to be utilized, it shall be filled with gravel before lowering the assembly. The slotted pipe and other pipes shall be provided with proper guides to keep them in the centre of the bore to ensure uniform gravel packing all around.

e. Gravel Packing
All gravel shall consist of hard rounded particles reasonably uniform in diameter and shall be of size, determined after analyzing the character of the water bearing formation tapped. The gravel shroud around the screen shall be uniform. It should be free from dust, dirt and other vegetable matters. Gravel packing once started shall be carried out continuously until it is completed. Pea gravel/Stone Chips shall be thoroughly washed.

f. Development of Bore well
The well shall be developed either by surging and agitating or by over pumping and back washing with an air lift and high velocity jetting. The tube well shall be developed as per IS 2800 -1979 or latest by air compressor to be arranged by the contractor as required and stipulated in BOQ to obtain the maximum discharge available from the completed tube well. Another acceptable method may also be adopted. This development process shall be continued until the stabilization of sand and gravel particles has taken place. The development shall continue until the gravel should stop sinking, discharge of depression ceases to improve and the sand content is not more than 20parts per million. A record of the hours of working of Air compressor shall be maintained by Employer Engineer which will be signed by the contractor or his authorized representative. Payment for development of tube well shall be made at the hourly rate indicated in the schedule of quantities for the actual period during which the Air-Condition has worked. A statement showing the quantity of gravel initially filled in the bore and the quantity added during development should be prepared by the contractor and got signed by the representative of the Engineer.
g. **Disinfection**
The well shall be disinfected after completion of test for yield. All the exterior parts of the pump coming in contact with the water shall be thoroughly cleaned and dusted with powdered chlorine compound. In fact it shall be disinfected every time a new pump is installed or the one installed is replaced after repairs.

The stock solution of chlorine may be prepared by dissolving fresh chlorinated lime. For obtaining an applied standard concentration of 50 PPM, 1 litre of the stock solution shall be used to treat 300 liters of water.

h. **Grouting and sealing**
Grouting and sealing of tube well may be done, if required depending upon the site conditions and the quality of the discharge of the strata encountered. To ensure that the grout shall be provided a satisfactory seal, it shall be applied in one continuous operation. Sealing of the tube well may be done by grouting the annular space between bore and the housing pipe, with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4: coarse aggregate 20 mm nominal size) to a depth of 5m below the grouted level.

i. **Handing over of the bore well.**
The tube well shall be handed over in complete shape. The housing pipe shall be closed by a well cap for the period between the completion of the tube well and the installation of the pump set.

The following information shall be furnished by the drilling agency on completion of the tube well:

i. Strata chart of the tube well indicating the different types of soils met with, at different depths.

ii. Samples of strata collected, neatly packed and correctly marked in sample bags.

iii. Chart of actual pipe assembly lowered indicating the size of pipes, depth ranges, where slotted/strainer pipes have been used, depth and diameter of housing pipe, reduced level of the top of the housing pipe and the diameter and depth of the bore hole.

iv. Position of every joint in the well assembly.

v. Hours of development done by the compressed air, pump sets or by other means.

vi. Pumping water level at the developed discharge.

vii. Two copies of test certificates of the water samples results from approved testing agency.

viii. Results of development along with levels of static subsoil water and depth of draw for steady discharge.

ix. Results of mechanical (sieve) analysis of samples of aquifer materials wherever applicable.

x. Yield analysis and recommendation on the safe pumping yield, pump settings and specifications for suitable pumps etc.

xi. Verticality tests results to be recorded in accordance with IS:2800-1979

xii. TUBEWELL DATA: - Shall be decided by the Engineer-in-charge.

j. **Water for drilling –** Contractor shall make his own arrangement for water required for drilling purposes as well for development purposes.

k. **The design for the tube well indicating the depth range of the aquifer zones to be tapped shall be given after a detailed study of the data collected during drilling operations.**
The slotted pipes should have an effective open area of at least 15% and the slotted size should be 1.6 mm. All pipes shall be painted fresh before lowering. The pipes shall be welded thoroughly all round to prevent leakage and breakage. Centering guides may be used to maintain the verticality of the tube wells which shall be tested.

The annular space between the bore well and tube well assembly shall be packed with well-graded pea gravel of good quality, durability and high sphericity.

**20. Restroom Cubicle System**

a. **SCOPE:** The scope of work shall include providing and fixing of cubicle partitions as per manufacturer’s guide under the supervision of the Engineer-in-charge.

b. **GENERAL:** Restroom Cubicle System shall be highly resistant against water, chemical and impact.

c. **MATERIALS**

i. All accessories shall be made of powder-coated Aluminium grade 6063-T5. The doors, pilasters and intermediate partitions shall be 12 mm thick High Pressure Laminates (HPL) compact board (or phenolic board) with chamfered edges.

ii. The HPL compact boards are manufactured from sheets of special craft and decor papers, impregnated with thermosetting synthetic resins which are fused together under heat and high pressure. HPL compact boards are laminated on both sides with suede finish. Top surfaces shall be Melamine-coated which is scratch and impact resistant.

d. **DOORS**

All doors shall be of single colour, 12 mm thick HPL compact board with chamfered edge. Each will be supported by 3 Nylon Hinges (4 for accessible restroom) affixed to the pilaster, completed with Nylon Coat Hook and Nylon Door Knob. Door stopper channel is provided at its vertical end and incorporated with Rubber Lining to dampen noise.

e. **PILASTERS**

All pilasters shall be of same colour as doors, 12 mm thick HPL compact board with chamfered edge, completed with Nylon thumb turn for locking doors. Colours different from the doors, if required, shall be provided as per the directions of the Engineer-in-charge. The pilaster is affixed to the Top Rail and secured from the top of the Top Rail. The floor clearance is 150 mm. All pilasters shall be supported by adjustable foot and non-corrosive steel inserts or as per approved by the Engineer-in-charge. The base of the adjustable foot shall be anchored to the floor with a clearance height of 150mm.

f. **TOP RAIL**

Heavy-duty Aluminium H-section Top Rail Channel, 70 mm x 125 mm x 5 mm (cross-section dimension, W x H x T), shall be anchored to the wall with Mild Steel Wall Bracket. Pilaster shall be section-fixed onto the bottom slot of the Top Rail for maximum strength, stability and alignment of the system.

g. **INTERMEDIATE PARTITIONS**
All intermediate partitions shall be one continues panel without any joints and of same colour as door, 12 mm thick HPL compact board with Aluminium U channel, affixed at its ends (to the wall and pilaster) with edges chamfered. For ultimate stability of the system, the length of the intermediate panel shall not exceed 1800 mm. The intermediate panel shall be anchored to the wall with powder coated or anodized Aluminium U channel.

h. ACCESSORIES
Each restroom cubicle will be equipped with the following accessories (as per BOQ):

i. Heat & Bacteria Resistant Polyamide / Nylon door knob/ nylon door knob

ii. Heat & bacteria resistant polyamide / nylon privacy thumb turn thumb-turn with occupancy indicator.

iii. Heat & bacteria resistant polyamide / nylon coat hook

iv. Heat & bacteria resistant polyamide / nylon cover gravity hinges with 3 choices of standard, gravity -to-open or gravity-to-close.

v. Aluminium door stopper channel

vi. Rubber door stopper lining.

i. COMPARTMENT DIMENSIONS
The compartment dimensions shall be as per site dimensions / detailed drawings. The contractor shall submit shop drawings for the approval of Engineer-in-charge prior to its execution at site. However, for guidance purpose, following are the representative dimensions subject to site conditions:-

- Width - 900 mm
- Door - 600 mm
- Depth - 1550 mm
- Height - 2105 mm (including 150 mm gap from bottom)

j. FINISHES
HPL compact boards are available in a variety of brilliant colours and wood-grains. The contractor shall get the finishes approved before execution of work at site.

k. INSTALLATION
Installation shall be executed under the supervision of manufacturer's site supervisor(s) and shall be carried out in accordance with the manufacturer's installation instructions and in accordance with the instruction / approval of the Engineer-in-charge.

l. METHOD OF MEASUREMENT
Complete work of partitions shall be measured for floor area treated. This includes all partitions, doors and related fittings and accessories.

21. High Pressure Laminates façade, walls and ceiling panelling system
Max Exterior panels are duromer High-Pressure Laminates (HPL) in accordance with EN 438-6 Type EDF that are produced in lamination presses under great pressure and high
temperature. Double-hardened acrylic PUR resins provide extremely effective weather protection that is particularly suitable for long lasting balconies and façade claddings.

**Description / Composition**

Max Exterior Panels are high pressure laminates (HPL) according to European norm EN 438. HPL are sheets consisting of layers of cellulose fibrous material (normally paper) impregnated with thermosetting resins and bonded together by the high pressure process.

The process, defined as the simultaneous application of heat (≥ 120°C) and high specific pressure provides flowing and subsequent curing of the thermosetting resins to obtain a homogenous non porous material (≥ 1,35 g/cm³) with the required surface finish.

Basically 2/3 of the HPL consists of paper and the remaining 1/3 of cured phenol-formaldehyde resins for the core layers and melamine-formaldehyde resin for the surface layers plus an urethane-acrylic coating in case of HPL Exterior.

The resins belonging to the group of thermosetting resins are irreversibly cross linked by chemical bonds formed during the curing process producing a nonreactive, stable material with characteristics which are totally different from those of its component parts.

HPL are supplied in sheet form in a variety of sizes, thicknesses and surface finishes. Retardant F-quality, not containing halogens.

**Standards:**

EN 438 – 6 applies to Exterior-grade Compact laminates of thickness 2mm and greater. It specifies requirements for standard and flame-retardant laminates intended for use under outdoor weather conditions such as direct sunlight, rain and frost. Two levels of performance are specified; one for moderate exterior conditions, and the other for severe exterior conditions. Laminates complying with this Part of EN 438 are referred to as Exterior-grade Compact laminates, and are characterized by their high tensile strength, high impact resistance, thermal shock resistance, and resistance to weather and corrosion.

They are available in a variety of decorative colors, with high resistance to colour change and aging in outdoor applications. When they are self-supporting Exterior-grade Compact laminates are ready for installation, and only require cutting to size, drilling, etc. to suit the application. EN 438-2 specifies the methods of test relevant to this part of EN 438.EN 438 – 7 (Norm Conformity) and CE Certificate.

**Evaluation of conformity**

The compliance of a wall or ceiling panel/siding with the requirements of this standard and with the stated values or classes shall be demonstrated by:

- Initial type testing;
- Factory production control by the manufacturer, including product assessment.

Products may be grouped into families where it is considered that a characteristic (or characteristics) is (are) Common to all products within the family. Compliance with the conditions of this annex is achieved, the certification of conformity (EC Certificate of conformity) is awarded to HPL Gmbh, and which entitles HPL Gmbh to affix the CE marking.
Properties:

- Weather resistant to EN ISO 4892-2
- Lightfast acc. to EN ISO 4892-3
- Double hardened
- Scratch resistant
- Solvent resistant
- Hail resistant
- Easy to clean
- Impact resistant EN ISO 178
- Suitable for all exterior applications
- Decorative
- Self-supporting
- Bending resistant EN ISO 178
- Frost resistant -80°C to 180°C
- Heat resistant -80°C to 180°C
- Easy to install

<table>
<thead>
<tr>
<th>Properties</th>
<th>Test method</th>
<th>Unit of measurement</th>
<th>Standard values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Thickness</td>
<td>...</td>
<td>mm</td>
<td>6</td>
</tr>
<tr>
<td>Apparent density</td>
<td>EN ISO 1183-1</td>
<td>g/cm²</td>
<td>1.35</td>
</tr>
<tr>
<td>Flexural Strength</td>
<td>EN ISO 178</td>
<td>Mpa</td>
<td>≥ 80</td>
</tr>
<tr>
<td>Modulus of Elasticity</td>
<td>EN ISO 178</td>
<td>Mpa</td>
<td>≥ 9000</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>EN ISO 527-2</td>
<td>Mpa</td>
<td>≥ 60</td>
</tr>
<tr>
<td>Co-efficient of Thermal Expansion</td>
<td>DIN 52328</td>
<td>1/K</td>
<td>18x10^-5</td>
</tr>
<tr>
<td>Fire behavior</td>
<td>EN 13501 -1</td>
<td>MA39 VFA Vienna</td>
<td>B-s2, d0 for 6mm</td>
</tr>
<tr>
<td></td>
<td>ASTM E 84</td>
<td>Class (Flame Spread Index)</td>
<td>10 (Class 1)</td>
</tr>
<tr>
<td></td>
<td>ASTM E 84</td>
<td>Smoke developed Index</td>
<td>95</td>
</tr>
</tbody>
</table>

Surfaces:

- NT
- NH (Hexa)/NT (format 4100 x 1854 mm only)
- NG* (Gloss)/NG (Gloss) (format 4100 x 1300 mm only)

Formats:

9’2 1/4” x 4’ 3” = 39.25 sf (2800 x 1300 mm)
13’ 5 1/8” x 4’ 3” = 57.44 sf (4100 x 1300 mm)
9’2 1/4” x 6’ 5/8” = 55.79 sf (2800 x 1854 mm)
13’ 5 1/8” x 6’ 5/8” = 81.65 sf (4100 x 1854 mm)

Core:

F-Quality, flame-retardant, colour brown

Thicknesses:

Panels with double-sided decor:
Thickneses Tolerances (EN 438-6, 5.3)

4,0 - 4,9 mm ± 0,3 mm
5,0 - 7,9 mm ± 0,4 mm
8,0 - 11,9 mm ± 0,5 mm
12,0 - 13,0 mm ± 0,6 mm

Storage and transport:
Storage and transport shall be in accordance with the general processing recommendations for HPL. No special precautions need to be taken. HPL are not classified as a hazardous product. No labelling is required.

Handling and machining of HPL – HPL:

The usual safety requirements of fabrication and machining have to be followed with regard to dust
- Dust separation,
- Dust extraction,
- Fire prevention etc.

Because of the possibility of sharp edges protective gloves should be worn when handling Laminates. The contact with dust from HPL does not present any special problems, however a small percentage of personnel may be sensitive or even allergic to matching dust in general.

Environmental and health aspects in use:
HPL are a cross-linked, duromer material that is chemically inert. Due to their very low permeability HPL act as a barrier against possible gaseous emissions.

- HPL are approved for direct contact with foodstuff.
- The decorative surface of HPL is resistant to all common household solvents and chemicals and has therefore been used for many years in applications where cleanliness and hygiene are demanded.
- The non-porous surface is easy to disinfect with hot water, steam and all types of disinfectants used in hospitals and other commercial applications.

Maintenance:
As HPL do not suffer from corrosion and oxidation, no further surface protection and no maintenance apart from cleaning is needed.

HPL in case of fire:
HPL are difficult to ignite and have a low spread of flame. The evacuating time in case of fire is therefore prolonged. In case of lack of oxygen, the fire can produce toxic substances due to incomplete combustion as with any other organic material. HPL are also available in F-quality (fire retardant) and do not contain halogenated fire retardants. In case of fires in which HPL are involved, the same Fire Fighting techniques should be employed as with other wood based materials.

Energy recovery:
Due to their high calorific value (18 – 20 MJ/kg) HPL are ideal for thermal recycling. When burned completely at 700°C, HPL are transformed to energy, water and carbon dioxide. Well controlled burning processes are achieved in modern approved industrial incinerators. Ashes of this process can be brought to control waste disposal sites. They do not contain heavy metals.

**Waste disposal:**
HPL can be disposed on controlled waste disposal sites according to current national and/or regional regulations.

**Technical data**
- **Physical-chemical characteristics**
  - Density ca. 1.35 g/cm³
  - Solubility: insoluble in water, oil, organic solvents
  - Calorific value 18-20 MJ/kg
  - Ignition temperature ca. 400 °C
  - Thermal decomposition above 250°. Depending upon burning conditions (lack of oxygen, temperature) toxic substances may be emitted; HPL do not melt
  - Dangerous reactions: none
  - Heavy metals: none

- **Storage, transport and handling**
  - HPL are classified as non-hazardous; there are no special requirements.
  - Use gloves to protect from sharp edges and wear safety glasses when machining.
  - No Special working equipment is necessary, except protections to minimize dust exposure in case of sheet machining
  - 9.2.3 Protection against fire: as with wood and wood based materials

- **Machining**
  - Exposure limit: dust below 2 mg/m³

- **Extinguishing media**
  - all common media applicable

- **Health information**
  - HPL are not considered to be dangerous for humans and animals. There is no evidence of toxicological effects and eco-toxicity. The surface is physiologically safe and approved for use in contact with foodstuff acc to EN1186.

**3. Façade System:**

**Introduction to Façade System**
Rain screen façade is one of the most modern techniques of the cladding on the dead walls and dry wall.

Today, rear-ventilated facades are amongst the most popular façade systems. In addition to their functional safety, architects value the design possibilities provided by the
use of rear-ventilated facades. The system allows for a variety of facade claddings. The design can thus be individually harmonized with the characteristics of the building. Material combinations of various cladding materials can also be easily implemented. Rear-ventilated facade systems, which include the structural division of insulation and weather protection materials. These systems are thus less susceptible to damage than other facade systems. In addition, fire, noise and lightning protection requirements can be implemented easily and creatively.

**Technology Behind**
- The system is a form of double-wall construction. Outer layer to keep out the rain, inner layer to provide thermal insulation, prevent excessive air leakage and carry wind load.
- The outer layer breathes like a skin while the inner layer reduces energy losses.
- The structural frame of the building is kept absolutely dry, as water never reaches it or the thermal insulation.
- Evaporation and drainage in the cavity removes water that penetrates between panel joints.
- Water droplets are not driven through the panel joints or openings because the rain screen principle means that wind pressure acting on the outer face of the panel is equalized in the cavity.
- The temperature is dispersed in the cavity and ventilated through the openings.

**Features of Rain Screen Façade**
- Energy Efficiency
- Sustainability Efficiency
- Thermal Insulation
- Rain Protection
- Protection against Moisture & Condensation.
- Sound Insulation

**Advantage of Rain Screen Façade**
- Low maintenance costs.
- Perfect thermal insulation.
- Perfect weather resistant functions.
- Increased fire safety, provided by the application of non-flammable and fire-resistant materials.
- Increased sound and vibration insulation decreased fundament loading due to the reduced wall thickness.
- Minimum requirements to wall surface. (unevenness)
- Exact cost estimation of the façade.
- Installation under any weather conditions.
- Long term value retention & appreciation of the building.

4. **Aluminium Sub Construction:-**

**Introduction to Fixing system (LT system)**
LT System mainly comprises of ‘L’ & ‘T’ Profiles, along with aluminium brackets, MBE rivets & necessary accessories. Aluminium 6063T6 is mainly used for profile extrusion along with the brackets.

6063T6 is an aluminium alloy with magnesium and silica as the alloying elements. The standard controlling its composition is maintained by the aluminium association. It has generally good mechanical properties and is heat treatable and viable. It is similar to the British aluminium alloy HE9.

This is mostly used for extruding shapes for architecture profiles, particularly Façade. It is typically produced with very smooth surfaces fit for anodizing.

Profiles & Bracket Finish
- ‘L’ & ‘T’ Profiles are Black Anodized – 15 Microns
- Aluminium Brackets are Natural Anodized.

LT System – Methodology
- Primarily Aluminium bracket is fixed along with the separators to the finished wall using SS – anchor fasteners.
- Standard ‘L’ & ‘T’ – Profile is fixed to the Aluminium bracket using Self Drilling Screws.
- Panel is fixed on Aluminium profiles using MBE rivets.
- Installation of the panel must occur in a stress free manner using fixed and sliding points.
- The panels must be mounted to adjacent panel using an expansion joint of 8mm.
- For Rear ventilation system, required gap of minimum 200 cm2/ per meter.

Advantages of LT System
- Cost Effective.
- Time Effective
- Easy to Install.

Types of LT System
- LT – 01 System
- LT – 02 System

LT – 01 System

Technical Specification Text for Installation

Installation of Max Exterior panels will be done by MBE Rivets (with Fixed and Sliding Points) with minimum recommended Aluminium ‘T’ section (100x60x2mmthk) and ‘L’ section (60x40x2mm thk) held by Wall Bracket (90x80x65x4 – 2 mm thk / 175x80x65x4 – 2 mm thk) with Wind load and Dead load slot as per design, anchored by standard Hilti/Fischer or equivalent make anchor fasteners along with Thermal Separator.

Installation of HPL Panels will be done using Rear Ventilated Principles only which is ensured by providing gaps of 200 cm2 / Per meter (for free flow of air behind the façade) for the façade and using the framework with no horizontal section*. Projection from the Finish wall level to Finish façade: 90 mm to 130mm
- **LT - 02 System**
  
  **Technical Specification Text**

  Installation of Max Exterior panels will be done by MBE Rivets (with Fixed and Sliding Points) with minimum recommended Aluminium T section (75x37x2.8 mm thk) and L section (38x38x2.8mm thk) held by Wall Bracket (90x55x36x4 mm thk / 175x55x36x4 mm thk) with Wind load and Dead load slot as per design, anchored by standard Hilti/Fischer or equivalent make anchor fasteners along with Thermal Separator.

  Installation of HPL Panels will be done using Rear Ventilated Principles only which is ensured by providing gaps of 200cm² / Per meter (for free flow of air behind the façade) for the façade and using the framework with no horizontal section.

  All specification has to be approved by Authorized Façade Consultant.

  Projection from the Finish wall level to Finish façade: 50 mm to 70mm.

**Standards:-**

This Structure design report is prepared to evaluate the Structure Performance of the Aluminium Frame Work to Support HPL Panels System to ensure the total Stability of the entire system.

| Structure Analysis is done utilizing Profiles of Extruded aluminium sections for a design Wind Pressure of Confirms to 6063 - T6 grade as per IS 8147-1976 maximum permissible deflection of the aluminium members are taken as span /175 as per IS 8147 -1976 |

**Fastening & Fixtures**

- **Spacing Details**

The Spacing of the Rivets is different for different Applications.

- **Panel joints**
The joints must be made at least 8 mm wide so that changes in size can take place without hindrance.

Element length = a
Element width = b

\[ A \text{ or } b \text{ (in mm)} = \text{expansion clearance} \]

500

- **Rivet details**

Rivets are from MBE, it must be put in place with a flexible mouthpiece of clearance 0.3 mm.

- Rivet pin: steel material-no. 1.4541
- Pull-off strength of rivet pin: ≤ 5.6 KN
- Diameter of drill hole in Max Exterior panels
  - Sliding points: 8.5 mm or as required
  - Fixed points: 5.1 mm

Diameter of drill hole in the Aluminium substructure: 5.1 mm

- **Sliding Point & Fixed Point**

The diameter of the drill hole in Max Exterior must be drilled larger than the diameter of the fastening, depending on the required expansion clearance. The head of the fastening must be big enough so that the drill hole in Max Exterior is always covered. The fastening is placed in such a way that the panel can move. Riveted with flexible mouthpiece. The defined clearance of the rivet head to the surface of the panel (0.3 mm) allows movement of the element in the drill hole. The Centre point of the drill hole in the sub construction must coincide with the Centre point of the drill hole in the Max Exterior panels. Drill with a centering piece. The fastenings should be put in place starting from the middle of panel outwards.
• **Aluminium Sleeves**
  This is used to convert sliding point to Fixed Point & is placed in the panel surface level. Expansion & Shrinkage are constrained.

• **Self-Treading Screw**
  These fastening are corrosion protected, used to fix the Aluminium profiles to Aluminium brackets. It makes excellent fasteners for attaching metals.

  These screws are used to fix Brackets on MS Structure. If the screw is reinstalled, new threads are not cut as the screw is driven. The screws shall be of HILTI / Equivalent make of size 5mm dia and 13mm in length (5mm x 13mm)
Anchor Fastener

<table>
<thead>
<tr>
<th>Make</th>
<th>Application</th>
<th>Product Type</th>
<th>Anchoring Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fischer</td>
<td>Façade</td>
<td>SXR</td>
<td>Concrete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FUR</td>
<td>Concrete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>Concrete</td>
</tr>
</tbody>
</table>

5. Site Equipment's: -

- **Riveting Gun**
  
  *Gesipa 7250037 Accu bird*

  14.4V li-ion Cordless
  
  Riveting Tool (1 Battery)
  
  Working range up to
  
  5mm rivets in all materials.
  
  Also BULBTITE rivets 4.0, 5.2 and 6.3mm aluminium and steel.
  
  Will complete 1000 cycle.
  
  4.0mm aluminium rivets on a single Charge.

**Features**

- Cable less riveting tool for outdoor and indoor applications
- High speed constant forward and backward jaw assembly movement, saves energy and increases setting frequency.
- Highly reliable, total electric control and no mechanical switching.
- Electronic temperature and overload monitoring.
- Efficient agronomy – ideal Centre of gravity position and low effort work
- Easy operation - exchange nosepieces and wrench always on hand, compact and shockproof plastic housing

- **Cutting Machine for Panel Cutting**
  
  *Bosch GKS 230*

  Rated power input 2,100 W
  
  No-load speed 5000 rpm
  
  Weight without cable 7.6 kg
  
  Saw blade bore 25 mm
  
  Saw blade diameter 235 mm
  
  Cutting depth
• Cutting Machine Drill bits

• Flexible Mouth Piece

The rivets are put in place with Flexible mouth piece. The defined clearance of the rivet head to the surface of the panel (0.3) allows movement of the element in the drill hole.

22. SAMPLES OF MATERIALS:

a. Sample of all materials/ fittings and fixture to be used in the work such as doors, windows, tiles, sanitary, water supply, drainage fittings and fixtures shall be submitted well in advance by the contractor for approval from the Engineer-in-charge of work in writing before placing orders for the entire quantity required for completion of work. Samples approved by the EIC/ Client shall be kept in Sample Room under the charge of EIC and shall retain till completion of work.

b. Finished items in respect of typical portion of works of repetitive nature such as typical room, toilet, railing, door, window or any other work desired by the engineer-in-charge shall be prepared by the contractor to the satisfaction of Engineer-in-charge and got approved from him in writing before the commencement of these items for the entire work.

c. The requirements for preparation of samples shall be observed and fulfilled by the contractor well in advance to avoid any detriment to the general progress of work. In other words, this will not be allowed to have any effects on the general progress of work or on any of the terms and conditions of the contract. No claims of any kind whatsoever including the claims of extension of time will be entertained due to the incorporation of this requirement.

23. GRIHA REQUIREMENTS

Materials shall be procured by the contractor keeping in view the recycled content to conform the GRIHA requirements.

24. VARIATION IN CONSUMPTION OF MATERIALS:

The variation in consumption of material shall be governed as per CPWD specification and clauses of the contract to the extent applicable.

25. MISCELLANEOUS:

Materials manufacture by reputed firms and approved by Engineer – in charge shall only be used. Only articles classified as “First Quality” by the manufactures shall be used unless otherwise specified. Preference shall be given to those articles which bear ISI certification marks. In case articles bearing ISI certification marks are not available the quality of sample brought by the contractor shall be judged by the standards laid down in the latest
CPWD specifications. For items not covered by the latest CPWD specification, relevant ISI standards shall apply.

26. TESTS:

a. Materials brought at site of work shall not be used in the work before getting satisfactory test results for Mandatory tests as per relevant provisions in Latest CPWD Specifications for works. Normally, part rate payment shall be allowed in the running account bills only if the materials are tested and test results are found to be satisfactory to by the Engineer-in-charge. These tests shall be got done from laboratories certified and approved by competent central/state Governments or the laboratory set up by the contractor at site as per directions of EIC/Consultant.

b. The Engineer - in - charge of work shall check the test results and satisfy himself before allowing any payment in the running /final bill.

27. SIGNAGE & ASSOCIATED WORKS

a. Signage (Internal & External)

i. The scope of the work includes preparation of the shop drawings (based on the architectural drawings), fabrication, supply, installation and protection of the Signage, till completion and handing over of the work.

m. The item of work for the respective signage shall be conforming to BOQ. However the rate shall cover all operations, fabrications and their installations and materials required for finished product and nothing extra shall be payable on this account.

n. The signage work shall be got executed through specialized fabricator having experience of similar works. The Contractor shall submit the credentials of such fabricator for the approval of the Engineer-in-Charge.

o. The Contractor shall submit the Design, Size and installation procedure along with samples to Engineer-in-Charge for approval. Approved samples will be kept at site till the whole work is completed. Engineer-in-Charge has right to modify the design of the approved samples also during the entire period of the contract without change in rates etc. and contractor is bound to follow these written instruction/changes in design/size etc. from Engineer-in-Charge.

p. The typical patterns shown in the Bill of Quantities are only indicative. The Contractor shall submit shop drawings, for approval of the Engineer-in-Charge, for fabricating signage with detailing of frame work, if any, along with the fixing details. The details of the signage including location, etc. shall be shown in the shop drawings.

q. The Contractor shall procure and submit to the Engineer-in-Charge, samples of various materials for the signage work, for approval. After approval of samples of materials, the Contractor shall prepare sample(s) for approval of Engineer-in-Charge. The material shall be procured and the mass work taken up only after the approval of the mock up by the Engineer-in-Charge. The mock-up shall be dismantled and removed by the contractor as per the directions of the Engineer-in-Charge. Nothing extra shall be payable on this account.
r. The finished surface shall be free of any defects like dents, waviness, scratches, stains etc. and shall have uniform finish. Any defective work shall be rejected and redone by the Contractor at his own cost. The finished surface shall therefore be protected using protective tape which shall be removed at the time of completion of the work. The surface shall then be suitably cleaned using non-abrasive approved cleaner for the material. Nothing extra shall be payable on this account.

s. The item includes the cost of all inputs of labour, materials, T & P other incidental charges, wastages etc. The items also include providing and fixing with stainless steel anchor fasteners or other suitable arrangement for fixing the signage.

t. The item includes the cost of all inputs of labour, materials, T&P, other incidental charges, wastage etc. The entire work shall be carried out to the satisfaction of Engineer-In-Charge.

b. External Signage

i. The electrical power supply points, if required, for operation of the signage shall be provided by the Client.

ii. The contractor shall submit the design for the support structure, including foundations, if required, for the approval of the Engineer in Charge and nothing extra shall be paid to the contractor in this account.
CHAPTER 3

TECHNICAL SPECIFICATIONS- PLUMBING & SANITARY WORKS

SECTION 1  GENERAL REQUIREMENT

1. Scope of work

The work shall in general conform to the Latest CPWD Specifications for works as mentioned in Schedule ‘F’ of the GCC. Work under this Contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required. The Contractor is required to completely furnish all the plumbing and other specialized services as described hereinafter and as specified in the schedule of quantities and/or shown on the plumbing drawings.

SECTION 2  PLUMBING FIXTURES

1. General

a. Work under this Part shall consist of furnishing all materials & labour necessary and required to completely install all sanitary fixtures, chromium plated fittings and accessories as required by the drawings and specified in the Bill of Quantities.

b. Without restricting to the generality of the foregoing the sanitary fixtures shall include the following:-

i. Sanitary fixtures

ii. Shower trays

iii. Chromium plated fittings

iv. Porcelain or stainless steel sinks

v. Accessories e.g. towel rods, toilet paper holders, soap dish etc.

vi. Whether specifically mentioned or not, the rates quoted for the installation of the fixtures, appliances and accessories shall be provided with all fixing devices, nuts, bolts, screws, hangers, fasteners as required.

vii. All exposed pipes within toilets and near fixtures shall be chromium plated brass or copper unless otherwise specified.

2. General

a. All sanitary fixtures, CP Fittings and CP/SS accessories shall be supplied at site of work as per manufacturers’ standard supply.

b. All fixtures and fittings shall be provided with all such accessories and fixing devices as are required to complete the item in working condition, even if the same is not specifically mentioned the Bill of Quantities, Specifications or shown on the drawings.
The rate quoted will include all devices for proper fixing arrangement, nuts, bolts, screws and required connection pieces etc.

c. Fixing screws shall be half round head stainless steel wood screws or bolts with Stainless Steel washers. Iron screws rust and will not be permitted.

d. All fittings and fixtures shall be fixed in a neat workmanlike manner true to level and heights shown on the drawings and in accordance with the manufacturer’s recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling or terrace shall be made good at Contractor's cost.

e. Contractor shall provide poly-sulphide sealant appropriate for its use for all fixtures fixed near wall, marble core seal and edges.

3. Water Closets

a. European W.C.

i. W.C. shall be any one of the following types:

- Wall hung wash down or
- single or double siphon type or
- As per BOQ

ii. Each W.C. set shall be provided with an approved type of plastic/wooden seat of approved finish compatible and fitting appropriately with the WC set with rubber buffers and hinges. The WC seat shall be those approved and accepted for fixing on a particular type of WC.

iii. The seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C.

iv. The edge between the fixture and the wall shall be sealed with approved type of poly-sulphide sealant.

b. Health faucet/spray (Optional)

A chromium plated spray with integral hand control valve and connected to a flexible pipe and angle valve with wall flange and hook are fixed as shown on the drawings or directed by the Engineer-in-charge. The angle valve and flange shall be paid under relevant item with abulation tap.

4. Wash Basins

a. Wash basins shall be wall mounted type or for under over/counter installation as specified in the BOQ.

b. Each basin shall be supported on MS galvanized or painted C.I. brackets and the basin securely fixed to wall or under/above counter installation. The design of the brackets shall suit the basin selected and as recommended by the manufacturer.
c. Each basin shall be provided with 32 mm dia. C.P. waste with overflow/ pop-up or standard waste with rubber plug and chain, 32 mm dia. C.P. brass bottle trap with CP pipe to wall and flange as specified in the BOQ.

d. The edge between the fixture and the wall or the counter shall be sealed with approved type of poly-sulphide sealant.

e. Washbasins shall be fixed at proper heights as shown on drawings. If height is not specified, the rim level shall be 79 cm or as directed by Engineer-in-charge.

f. Each washbasin connection (separately for hot and cold) shall be provided with angle valves with CP wall flange and CP connecting pipe and of required length.

5. Sinks

a. Sinks used shall be of any of the following types:

b. For kitchens, pantries, and designated utility rooms the sinks shall be stainless steel sinks with or without drain boards.

c. Each sink shall be supported by **MS galvanized** or painted C.I. brackets and clips and the basin securely fixed to wall or on the counter. The design of the brackets shall suit the basin selected and as recommended by the manufacturer.

d. Stainless steel sinks shall be provided with 40 mm dia. C.P. basket waste with plug (as supplied by manufacturer), 40 mm dia. C.P. brass “P” trap with CP pipe to wall and flange.

e. Each sink shall be provided with hot & cold CP mixer with approved type of a neck spout or individual taps as directed by the Engineer-In-Charge.

6. Shower set

a. Shower set shall comprise of hot & cold water mixer, C.P. shower arm with wall flange and shower head adjustable type.

b. Mixer shall be exposed type, single lever, concealed stop cocks with diverter and spout as selected by the Engineer-in-charge.

7. Accessories

a. Accessories shall be of any of the following types:

i. Towel rails

ii. Towel rings

iii. Coat hooks

iv. Soap dispensers

v. Soap dishes
b. 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.

c. 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.

8. Measurement & Rates

a. Sanitary fixtures shall be measured by numbers or as specified in BOQ.

b. Rates for all items mentioned above shall be inclusive of cutting holes and chases and making good the same, stainless steel screws, nuts, bolts, fastener and any fixing arrangements required and recommended by manufacturers, testing and commissioning.

SECTION 3  Soils, Waste, Vent & Rainwater Pipes & Fittings

1. Scope of work

a. Work under this Part shall consist of furnishing all labour, materials, equipment’s and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes and fittings as required by the drawings, and given in the Schedule of Quantities.

b. Without restricting to the generality of the foregoing, the system shall include the following:-

i. Vertical and horizontal soil, waste, vent and rain water pipes, and fittings, joints, clamps and connections to fixtures.

ii. C.I. Soil & uPVC rainwater pipes.

iii. Connection of all pipes to sewer lines as shown on the drawings at ground floor levels.

iv. Floor and urinal traps, cleanout plugs, inlet fittings and rainwater heads/Khurras.

v. Testing of all pipe lines.

2. General requirements

a. All materials shall be new of the best quality conforming to specifications and subject to the approval of Engineer-in-charge.

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

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

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

3. Piping System

a. Soil, Waste & Vent Pipes

i. The Soil & Waste pipe system above ground has been planned as a "two pipe system" as defined in BIS: having separate pipes for waste for kitchen sinks, showers, washbasins, AHU’s condensate drains and floor drains and is approved by Engineer-in-charge.

ii. All waste water from AHU’s plant and pump rooms, floor channels in basements will be provided with a deep seal trap before connecting to the main drain or vertical stack.

iii. Vertical soil & waste stacks shall be connected to a common horizontal drain pipe at basement ceiling or to an external manhole directly where feasible and shown on the drawings.

b. Rainwater Pipes

i. All terraces shall be drained by providing down-takes rainwater pipes.

ii. Rainwater pipes are separate and independent and connected to the storm water drainage system as shown on the drawings.

iii. Rainwater in enclosed courtyards shall be collected in catch-basins and connected to storm water harvesting chambers as shown in drawings.

iv. Any dry weather flow from waste appliances, AHU’s pump rooms, shall not be connected to the sewerage system.

c. Balcony/Planter drainage

All balconies, terraces, planters and other formal landscape areas will be drained by vertical down takes as per the landscape/architectural drawings and details.

d. Cast iron pipes & fittings (for Soil, waste, anti-siphon age pipes)

i. All pipes shall be straight and smooth and inside free from irregular bore, blow holes, cracks and other manufacturing defects. Pipes shall be centrifugally spun iron soil pipes conforming to sand cast to I.S. 3989.

ii. Standard weight dimensions shall be as follows:-

a. Sand Cast Iron Pipes & Matching Fitting shall be in conformity to I.S. 1729
b. Centrifugally cast (spun) iron pipes and fittings in conformity to I.S. 3989.

c. Hubless Centrifugally cast (spun) iron pipes epoxy coated inside and outside IS : 15905

e. uPVC pipes & fittings (For Rain Water Pipes etc.)

i. Where specified, Polythene pipes shall be uPVC pipes confirming to I.S: 4985-2000. The details of the nominal outer diameter, weight and working pressure shall be as per the standards, for the respective pressure rating as specified in the B.O.Q.

ii. Polythene pipes may be cold bending to a radius of not less than eight times of their external diameter. Pipes bent for smaller radius may be made by hot bending.

iii. Fittings used for Polythene pipes shall be compression moulded fittings matching to the above specifications.

f. Jointing

i. All Polythene pipes shall be Drip seal/Sealant and jointed as per manufacturer’s specifications and relevant I.S codes.

ii. All pipes shall be tested after installation for a pressure equal to twice the maximum working pressure in the line as per manufacturer’s specifications.

g. Fittings

1. Fittings shall conform to the same Indian Standard as for pipes. Pipes and fittings must be of matching IS Specification. Interchange of pipes of one standard with fittings on the other standard will not be permitted.

2. Fittings shall be of the required degree of curvature with or without access door.

3. Access door shall be made up with 3 mm 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.

h. Fixing

1. All vertical pipes shall be fixed by structural support 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).

2. Horizontal pipes running along ceiling shall be fixed on 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.
3. Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the Engineer-In-Charge/Building Contractor for making such provisions in the structure as necessary. All damages shall be made good to restore the surfaces.

4. Traps

a. 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 waste pipes 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 centring for the blocks. Size of the block shall be 30x30 cm of the required depth.

b. Urinal traps

Urinal traps/horn shall be cast iron P or S traps with or without vent and set in cement concrete block specified for floor traps.

c. 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 G.I. pipe without, with one, two or three inlet sockets welded on side to connect the waste pipe. Joint between waste and hopper inlet socket shall be Drip Seal. Inlet shall be connected to a C.I. P or S trap. Floor trap inlet hoppers and the traps shall be set in cement concrete blocks as specified in para above without extra charge.

d. Gratings for traps

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 as per BOQ.

e. Jointing

Soil, waste, vent and anti-siphonage pipes shall be jointed with Lead joint/Drip seal joint as mentioned in the BOQ. The following minimum procedures shall be complied with while making the pipe joints:-

i. Ensure that the pipes are clean internally and undamaged.

ii. The pipes shall be cut square with sharp tools.

iii. The cut ends of the pipes shall be filed/reamed and finished smooth.

iv. Any deformed ends shall be re-rounded.
v. It shall be ensured that the pipe ends shall enter the fittings and sockets to full depth of the jointing area.

vi. The pipe work shall be assembled in a manner such that it does not entail making of joints in restricted locations.

vii. Each metal pipe spigot shall be cantered with three lightly wedged pieces of hardwood or folded lead.

viii. The jointing surfaces shall be cleaned to remove any coatings or cutting oils, etc.

f. **Floor Trap Inlet/GI Inlet Fitting:**

   Traps and connections shall ensure free and silent flow of discharging water. Where specified, Contractor shall provide a special type cast iron or G.I. inlet hopper without or with one or two or three inlet sockets to receive the waste pipe. Joint between G.I. waste pipe and hopper inlet socket shall be Drip seal joint. Hopper shall be connected to a CI ‘P’ or ‘S’ trap with at least 50mm seal (hopper and traps shall be paid for separately). Floor trap inlet hoppers and the traps shall be set in cement concrete blocks/and supports as required for Floor trap above shall be provided without any extra charge.

5. **Cleanout Plugs**

a. **Cleanout Plug on soil pipes**

   Clean out plug 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 plugs shall terminate flush with the floor levels. They shall be threaded and provided with key holes for opening. Cleanout plugs shall be Cast Brass suitable for the Pipe dia. With screwed to a G.I. socket. The socket shall be Drip seal caulked to the drain pipes.

b. **Cleanout Plug on Drainage Pipes**

   i. Cleanout plugs 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 plugs shall be of size matching the full bore of the pipe but not exceeding 150 mm dia. Cleanout Plugs on drains of greater diameters shall be 150 mm dia. Fixed with a suitable reducing adapter.

   ii. Cleanout Plug at Ceiling Pipes: - Cleanouts provided at ceiling level pipe shall be fixed to a CI flanged tail piece. The cleanout doors shall be specially fabricated from light weight galvanised sheets and angles with hinged type doors with fly nuts, gasket etc., as per drawing.
6. **Waste pipe from appliances**

   **a. General**
   
   i. Waste pipe from appliances e.g. washbasins, sinks and urinals shall be of heavy galvanized steel as given in the Schedule of Quantities or shown on the drawings.

   ii. 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 good engineering practice approved by the Engineer-In-Charge.

   **b. Galvanized pipes**
   
   Waste pipes from appliances shall be galvanized steel tubes conforming to I.S.1239 (Heavy class) and quality certificates shall be furnished. Pipes shall be provided with all required fittings e.g. tees, couplings, bends, elbows, unions, reducers, nipples, plugs. All G.I. waste pipes shall be terminated at the point of connection with the appliance with an outlet of suitable diameter. Pipes in chase shall be wrapped with bitumen tape and then painted with two coats of black bitumen paint. Exposed pipes with one coat of Zinc chromate with etch coating primer and two or more coats of synthetic enamel paint or as given in the Schedule of Quantities. Colour shall be as per the approved colour code.

7. **Cast iron pipes for drainage**

   **a. All drainage lines passing under building, in exposed position above ground e.g. basement ceiling etc. shall be cast iron pipes. Position of such pipes shall generally be shown on the drawings.**

   **b. Cast iron pipes shall be spigot & socket (S&S) centrifugally spun iron pipes conforming to I.S. 1536. (Class LA). Quality certificates shall be furnished.**

   **c. Fittings**
   
   Fittings used for C.I. drainage pipe shall conform to I.S. 1538 (Heavy class). Wherever possible, junction from branch pipes shall be made by a Y-tee.

   **d. Joints**
   
   i. Joints between pipes shall be made with pre-moulded rubber joints (Tyton Joints) supplied by the manufacturer to ensure compatibility and water tightness.

   ii. Joints between pipes and fittings shall be made by caulked spun yarn dipped in tar and molten drip seal 45 mm deep by hammering with caulking tools.

8. **Encasing pipe in Cement Concrete**
Cast iron soil and waste pipes 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 1.8 m. Rate for concrete round pipes shall be inclusive of pillars, supports, shuttering and centring.

9. Painting
   a. All cast iron, soil, waste vent, anti-siphon age and rainwater pipes in exposed location in shafts and pipe spaces shall be painted with two or more coats of synthetic enamel paint to over a priming coat to give an even shade.
   b. Paint shall be of approved quality and shade. Where directed pipes shall be painted in accordance with approved pipe colour code.
   c. G.I. waste pipes in chase shall be painted with two coats of bitumen paint, covered with polythene tape and a final coat of bitumen paint. Exposed pipes shall be painted with two or more coats of synthetic enamel paint over each priming coat.
   d. C.I. soil and waste pipes below ground and covered in cement concrete or lead pipes shall not be painted.

10. Cutting and making good
   a. Pipes shall be fixed and tested as building proceeds.
   b. Contractor shall provide all necessary holes cut outs and chases in structural members as building work proceeds. Wherever holes are cut or left originally, they shall be made good with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size) or brick work in cement mortar 1:2 (1 cement: 2 coarse sand) and the surface restored as in original condition.

11. Testing
   a. Testing procedure specified below apply to all soil, waste and vent pipes above ground including C.I. LA pipes laid in basement ceiling.
   b. 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 shall be certified for its calibration by an approved laboratory.
c. All materials obtained and used on site must have manufacturer’s hydraulic test certificate for each batch of materials used on the site. All testing equipment must be calibrated and shall carry certificate from an approved laboratory.

d. Testing soil, waste and rainwater pipes

i. 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.

ii. After installation all connections from fixtures, vertical stacks and horizontal drains including C.I. LA pipes shall be tested to a hydraulic pressure not exceeding 3 m. Such tests shall be conducted for each floor separately by suitable plugs.

iii. The entire installation shall be tested by smoke testing machine. The test can be conducted after the plumbing fixtures are installed and all traps have water seal or by plugging all inlets by bellow plugs. Apply dense smoke keeping the top of stack open an observe for leakages. Rectify or replace defective sections.

iv. 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.

e. 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.

12. Measurements

a. General

i. Rates for all items quoted shall be inclusive of all work and items given in the specifications and Schedule of Quantities.

ii. Rates are applicable for the work under floors, in shafts at ceiling level area for all heights and depths.

iii. Rates are inclusive of cutting holes and chase in RCC and masonry work and making good the same.

iv. Rates are inclusive of pre testing, on site testing, of the installations, materials and commissioning of the works.

v. Pipes (Unit of measurement, linear meter to the nearest Centimetre) or as specified in CPWD specifications.
b. All C.I. Soil, waste, vent, anti-syphonage and rain water pipes shall be measured net when fixed correct to a centimetre including all fittings along its length. No allowance shall be made for the portions of pipe lengths entering the sockets of the adjacent pipes or fittings. The above will apply to both case i.e. whether pipes are fixed on wall face or pillars or embedded in masonry or pipes running at ceiling level.

c. Pipes shall be measured per running metre correct to a centimetre for the finished work which shall include fittings e.g. bends, tees, elbows, reducers, crosses, sockets, nipples and nuts. The length shall be taken along centre line of the pipes and fittings. All pipes and fittings shall be classified according to their diameter, method of jointing and fixing substance, quality, and finish. The diameters shall be nominal diameter of internal bore. The pipes shall be described as including all cutting and waste. In case of fittings of unequal bore, the largest bore shall be measured.

d. Cement concrete around pipes shall be measured along the centre of the pipe line measured per linear metre and include any masonry supports, shuttering and centring cutting complete as described in the relevant specifications.

e. Slotted angles/channels shall include support bolts, nuts and clamps embedded in masonry walls with cement concrete blocks and nothing extra will be paid for making good the same.

f. Fittings

Unit of measurement shall be the number of pieces. Pipe fittings are included in the rate for pipes. Urinal traps, trap gratings, hoppers, cleanout plugs shall be measured by number per piece and shall include all items described in the relevant specifications and Schedule of Quantities.

g. Painting

Painting of pipes shall be measured per running metre and shall be inclusive of all fittings and clamps. No deduction for fittings shall be made.

h. Excavation for soil pipes

No payment shall be admissible with respect to excavation, refilling and disposal of surplus earth for cast iron soil and waste pipes laid below ground, in sunken slabs.

i. Engineer-in-charge’s decision with respect to the correct interpretation regarding mode of measurement shall be final and binding on the contractor.

SECTION 4  Water Supply Systems

1. Scope of work
a. Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to completely install the water supply system as required by the drawings, specified hereinafter and given in the Schedule of Quantities.

b. Without restricting to the generality of the foregoing, the water supply system shall include the following:
   i. Rising main from water supply pumps to all overhead tanks.
   ii. Distribution system from overhead tank to all fixtures and appliances for cold & hot water.
   iii. Insulation to hot water pipes within toilets.
   iv. Connections to all plumbing fixtures, and appliances.

2. General requirements
   a. 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.
   b. Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
   c. 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.
   d. As far as possible all bends shall be formed by means of a hydraulic pipe bending machine for pipes up to 25 mm dia. Bends and elbows may be used for pipe dia. greater than 32 mm.
   e. 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.
   f. Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals approved by the Engineer-In-Charge.
   g. Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

3. Water Supply System
   a. Contractor should study the site plan and water supply system diagram for overviews of the system.
   b. Source
      i. Water supply will be acquired from Municipal Main supply / Bore well.
      ii. The rising mains will be connected to the main fire static tank and then overflow into the main domestic water tank.
c. Water supply piping for garden hydrant and sprinkler and irrigation system will be separate and independent connected to a different pumping system.

4. G.I./ CPVC Pipes & Fittings

a. All pipe inside the building and where specified, outside the building shall be galvanized / CPVC steel tubes conforming to I.S. 1239 of class specified. When class is not specified they shall be heavy class.

b. Fittings shall be malleable iron galvanized / CPVC of approved make. Each fitting shall have manufacturer’s trade mark stamped on it. Fittings for G.I./CPVC pipe shall include couplings, bends tees, reducers, nipples, union and bushes. Fittings shall conform to I.S. 1879-(Section I to X).

c. Pipe and fittings shall be joined with screwed joints, after cutting a pipe with a hacksaw or a cutting machine care shall be taken to remove burr from the end of the pipe after reaming with a proper file.

d. Pipe threaded joints will be made by applying suitable grade of TEFLON tape used for drinking water supply. (Use of red and white lead sutli will not be permitted for screwed joints)

e. 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./CPVC pipes inside shall be fixed in wall chases well above the floor. No floor shall be run inside a sunken floor as far as possible. Pipes may be run under the ceiling or floors and other areas as shown on drawings.

f. Clamps

   i. G.I / CPVC pipes in the shaft and other locations shall be supported by clamps of design approved by Engineer-In-Charge. Pipes in wall chases shall be anchored by hooks. Pipes at ceiling level shall be supported on structural clamps.

   ii. Spacing of clamps, hooks etc. Shall be as per good engineering practice approved by the Engineer-in-charge

g. Unions

Contractor shall provide adequate number of unions on pipes 50mm and below to enable easy dismantling later when required. Unions shall be provided near each gunmetal valve, stop clock, or check valve and go on straight runs as necessary at appropriate locations as required and /or direct by Engineer-In-Charge.

h. Flanges

   i. Flanged connections shall be provided on pipes 65 mm and above as required or where shown on the drawings generally as follows:
- On straight runs not exceeding 30 m, near bends and at connections to main branch lines.
- On all valves ends
- On equipment/pump connections as necessary and required or as directed by Engineer-in-charge.

j. Flanged connections shall be made by the correct number and size of the bolts and made with 3 mm thick insertion neoprene gaskets. Bolt hole dia. for flanges shall conform to match the specification for C.I. sluice valve to I.S. 780 and C.I. butterfly valve to IS: 13095.

k. Trenches

i. All water supply pipes below ground shall be laid in trenches with a minimum cover of 60 cms. The width and depth of the trenches 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>15 mm to 50 mm</td>
<td>30 cm</td>
<td>75 cm</td>
</tr>
<tr>
<td>65 mm to 100 mm</td>
<td>45 cm</td>
<td>100 cm</td>
</tr>
</tbody>
</table>

ii. Sand filling

Where specified in the Schedule of Quantities, all G.I. pipes in trenches shall be protected with fine sand 15 cm all around before filling in the trenches.

l. Where shown on the drawings, main pipe lines may be run in masonry trenches from the pump house to the buildings in phase I & II, filled up with sand and buried in ground as per architectural/landscape details.

m. Painting

All pipes above ground shall be painted with one coat Zinc with each coating and two coats of synthetic enamel paint of approved shade and quality. Pipes shall be painted to standard colour code specified by Engineer-in-charge.

n. Pipe protection

i. Where specified in the Schedule of Quantities, all pipes in chase or below floor shall be protected against corrosion by the application of two coats of bitumen paint covered with bitumen tape and a final coat of bitumen paint before covering up the pipe.

ii. All G.I./CPVC water supply pipes below ground shall be protected against corrosion by applying one layer of 4 mm thick multilayer anticorrosive polymeric mix tape applied over a coat of primer as per recommendations of the manufacturers. (Pypcoat)

o. Insulation
Hot water pipes within a toilet /kitchen from hot water header shall be insulated with fire resistance closed cell chemically cross linked polyethylene is used in the forms of rolls, sheets and tubes. The thickness of insulation is 13mm on all sizes of pipes. Density of insulation is 30±2kg/cum.

5. Valves
   a. Ball valves
      i. Valves 50 mm dia. and below shall be screwed type ball valves with stainless steel balls spindle Teflon seating and gland packing tested to a hydraulic pressure of 20 kg/cm² and accompanying couplings and steel handles to B.S. 5351.
   b. Butterfly Valves
      i. Valves 65 mm dia. and above shall be cast iron butterfly valve to be used for isolation and/or flow regulation. The valves shall be bubble tight, resilient seated suitable for flow in either direction and seal in both direction. Valves shall be provided with matching flanges with neoprene insertion gasket 3 mm thick. P.N 1.6
      ii. Butterfly valve shall be of best quality conforming to IS: 13095.
   c. Non Return Valve
      i. Where specified non return valve (swing check type) shall be provided through which flow can occur in one direction only. It shall be single door swing check type of best quality conforming to IS: 5312.P.N.1.6
      ii. Each butterfly and slim type swing check valves shall be provided with a pair of flanges screwed or welded to the main line and having the required number of galvanized nuts, bolts and double washers of correct length.
      iii. Sluice valve shall be of approved makes conforming to I.S.:780 of class as specified.

6. Storage Tanks
   a. Overhead Tanks
      Overhead water storage tanks for water supply shall be reinforced cement concrete.
   b. Tank connection and accessories
      i. Contractor shall provide the following to each tanks:
         • Inlet and outlet connections to pumps, equipment and main pipe lines.
         • Tank overflows with mosquito proof gratings
         • Scour drain and valve as per drawings
• Water level gauge with approved type of brass gauges, plastic tube, a wooden board with level marking.

ii. Electronic level controllers, cabling, sequence controllers and all related equipment shall be provided by agency executing the pumping system work. Plumbing contractor shall provide necessary G.I. sleeves and cooperate with the contractor to ensure that the work is successfully executed.

7. Testing

a. All pipes, fittings and valves, after fixing at site, shall be tested by hydrostatic pressure of 1.5 times the working pressure or 10 kg /cm² whichever is more. Pressure shall be maintained for a period of at least 12 hours without any drop & withstand for 8 hrs.

b. A test register shall be maintained and all entries shall be counter-signed by Contractor(s) in the presence of Engineer-in-charge.

c. 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 by the Contractor during the defects liability period without any cost.

d. After commissioning of the water supply system, Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which do not effectively operate shall be replaced by new ones at no extra cost and the same shall be tested as above.

8. Measurements

a. G.I. pipes

i. G.I. pipes above ground shall be measured per linear metre (to the nearest cm) and shall be inclusive of all fittings e.g. couplings, tees, bends, elbows, unions, and flanges. Deduction for valves shall be made. Rate quoted shall be inclusive of all fittings, clamps, cutting holes chases and making good the same and all items mentioned in the specifications and Schedule of Quantities.

ii. G.I. pipes below ground shall be measured per linear metre (to the nearest cm) and shall be inclusive of fittings, e.g. couplings, tees, bends, elbows, unions. Deduction for valves shall be made. Rates quoted shall be inclusive of all fittings, excavation, back filling and disposal of surplus earth, cutting
holes and chases and making good and all other items mentioned in the specifications and Schedule of Quantities.

b. Gunmetal, cast iron, butterfly and non-return valves puddle flanges, level indicators and meters shall be measured by numbers.

c. Brick masonry chamber for valves and meters shall be measured by number and include all items given in the Bill of quantities.

d. Painting/pipe protection

Painting/pipe protection for pipes shall be measured per linear metre over finished surface and shall include all valves and fittings for which no deduction shall be made.

e. Engineer-In-Charge's decision with respect to the correct interpretation regarding mode of measurement shall be final and binding on the contractor.

SECTION – 5  Water Supply Pumping System & Allied services

1. Scope of work

a. Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required for the satisfactory supply, installation, completion and commissioning of water supply pumping system and allied works as described hereinafter, as specified in the schedule of quantities and/or shown on the plumbing drawings and described in the scope of work.

2. The System

a. The system described below is for the contractors bidding for the works to understand the extent and scope of work and the intent in the manner in which the water supply system is planned and shall be executed. This does not form a part of the contractor’s scope of work with respect to the various elements that are described in this paragraph.

b. Sources of supply

Local water supply for which a water main from the main road/ bore well to the underground water tank will be laid by contractor.

c. Underground water tanks

i. Static fire water storage tanks in compartments. Connections from the tube well water supply lines will be made into these tanks. Water will overflow into the Domestic Pure water tanks

- Domestic Water Pumping Systems
ii. Water supply to the various buildings will be made from a set of pumping sets to the overhead water and supplementary fire tanks located on the terrace of each building.

3. Rising Mains & level control system

a. Water from the pumps described above will fill each tank by a rising main to each tower.

b. To control the level in each tank and enable it to fill as the water demand so requires, each tank will be provided with a ball cock to shut off the water supply when the tank is full.

c. A set of electronic level sensing probes will be installed in each tank. The probes installed in each pumping system will be wired to a central electronic panel which will activate the pump when any one of the tank probe signals low water conditions and top up all tanks. No excess flow will occur due to the ball cock in the tank.

4. Level Controllers

a. Level controllers shall be electronic magnetic type using required number of stainless steel type probes, shrouded in PVC sheath or encapsulated in a stainless steel pipe. The level controller will be used for following applications:-

   i. Provide an audible high water alarm when water level in the sump reaches a pre-determined high level in the sump location at MCC panel installed in wall near sump location

b. Overhead tank level controller cum indicators

   i. Each OHT to be provided with required number of stainless steel electronically operated probes (housed in a stainless steel protective housing) and connected by a control cable to a central junction box connected to MCC panel located in the pump house at basement. A common multi-core cable from each group of buildings will be laid to the pump room in basement. The probes will function as follows:

   ii. To cut off the water supply pumps when all the OHT is full and to start the pump if any OHT level reaches at pre-determined low level.

   iii. Provision shall be made to enable the operation of the second duty pump in case the water level does not rise above a pre-determined level in the tank due to water demand which is higher than capacity of duty pump no.1 to meet.

   iv. Indicate the water level in each OHT in the level indicating panel installed in the pump room
v. Each OHT are also provided with a float valve to stop the supply in individual OHT when level reaches a cut off high level.

c. Control & Indicating Panel (For overhead and underground water tanks)

i. A centralized indicating stand-alone wall mounted panel fabricated from 14 g. with seven tank process MS sheet and painted inside and outside with stove enamelled finish with clear vertical panels for each group of buildings & tanks shall indicate water level in each tank by means of digital display unit to indicate water level in each tank in four levels (¼th, ½, ¾ and full). The panel shall be installed on the control console panel located in the pump room or as directed by the Project Engineer. The panel shall have:

ii. Digital level indicator panel meter for each water tank.

iii. Etched plate identification plates.

iv. Control cabling from MCC to the panel installed in the control room as directed by the Engineer-In-Charge.

v. Cabling from PHT sensing probes to the panel

SECTION 6   Pipelines & Fittings

1. Headers, piping and connections

a. All pipes within the plant room building in exposed locations and shafts including connections buried under floor and for suction and delivery headers shall be G.I. (Medium class) and thickness specified. Pipes up to 150 mm dia. shall conform to I.S. 1239.

b. Pipe 200 mm dia. and above shall be G.I. ERW tubes to IS 3589. If black pipes are available they shall be galvanized before use.

c. Fittings for G.I. pipes shall be approved type malleable iron or wrought iron screwed galvanized fittings for screwed joints. Fittings 200 mm dia. may be shop fabricated but shall be shop galvanized after fabrication.

d. All M.S. structural supports and clamps shall be galvanised. All the pipe work within plant room shall be adequately supported with G.I. structural supports from floor or ceiling as required and directed by Engineer-In-Charge.

2. Jointing

a. G.I. Pipes (Screwed joints)

Pipe shall be provided with metal to metal threaded joints. Teflon tape shall be used for lubrication and rust prevention. (USE OF LEAD /ZINC BASED JOINTING COMPOUND ARE NOT PERMITTED)

b. Flanged joints / Dead Joints
a. Flanges shall be provided on:
   i. Straight runs not exceeding 12-15 m on pipe lines 80 mm dia and above.
   ii. Both ends of any fabricated fittings e.g. bends, tees etc. of 50 mm dia or larger diameter. (When Permitted)
   iii. Both end of all suction delivery and other headers.
   iv. For jointing valves, appurtenances, pumps, connections with pipes, to water tanks and other places necessary and required as good for engineering practice.
   v. Flanges shall be as per applicable I.S. with appropriate number of G.I. nuts and bolts, 3 mm insertion rubber gasket complete.
   vi. The cost of flanges is included in the rates of pipes along with fittings.

c. Unions

Provide approved type of dismountable unions on pipes lines 50 mm and below near valves or inspector test/drain and assemblies and as required as per site conditions.

d. Vibration Eliminators

All suction and delivery lines and as shown on the drawings double flanged reinforced neoprene bellow type flexible pipe connectors shall be provided. Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connectors shall be as per site requirements in accordance with manufacturer's details.

3. Valves

a. Sluice valves
   i. Full way Sluice Valves shall be used on the suction connection to pumps and headers.
   ii. Sluice valves (80 mm dia. and above) shall be C.I. double flanged sluice valves with rising stem. Each sluice valve shall be provided with wheel in exposed positions and cap top for underground valves. Contractor shall provide suitable operating keys for sluice valves with cap tops.
   iii. Sluice valves shall be of approved makes conforming to I.S.780 PN1.6 class

b. Butterfly Valves (PN 1.6 rating)
   i. Butterfly Valves shall be used in all other locations as required conforming to IS 13095.PN 1.6
   ii. They shall have a cast iron body.
   iii. Disc shall be CI heavy duty electrolyses nickel plated abrasion resistant.
iv. The shaft to be EN-8 Carbon Steel with low friction nylon bearings.

v. The seat shall be drop tight constructed by bonding resilient elastomer inside a rigid backing.

vi. Built in flanged rubber seals.

vii. Actuator to level operated for valves above ground and T Key operated for valves below Ground.

viii. Built in flanges for screwed on flanged connections. Manufacturer’s details on fixing and Installation will be followed.

c. Non Return Valves (NRV PN 1.6 rating)

i. Non return valves will be used at location to allow flow only in one direction and prevent flow in the opposite direction.

ii. NRV shall be cast iron slim type with cast iron body and gunmetal internal parts and accompanying flanges. Valves shall conform relevant IS or match the butterfly valves. PN 1.6

iii. Built in flanges for screwed on flanged connections.

d. Ball Valves

Ball Valves up to 40 mm dia. shall be screwed type ball valves with stainless steel balls, spindle, Teflon seating and gland packing tested to a hydraulic pressure of 20 kg/cm² and accompanying coupling and steel handles (to B.S. 5351.

4. 'Y' Strainers (PN 1.6 rating)

Provide cast iron 'Y' type strainers with gunmetal internal strainers, CI screwed plug to be provided on all water tank suction connections to pumps.

5. Measurements (Part 1, 2 & 3)

a. General

1. Unit rate for individual items, e.g., pressure tanks, MCC, level controller, water tank are for purposes of payments only. Piping, headers, valves, accessories, cabling and MCC to measured separately in this contract only.

2. All items must include all accessories fittings as described in the specifications, BOQ and shown on the drawings.

b. Drainage Pumps & Sewage Pumps

Drainage pumps shall be measured by numbers and shall include all items as given in the specifications and schedule of quantities to provide a complete working system.

c. Level controllers & Alarms
Level controllers for each set of pumps shall be measured by number and inclusive of probes, cabling up to surface box near the pump and shall include all items as given in the specifications and schedule of quantities to provide a complete working system.

d. Piping Work

i. Suction and delivery headers for each pumping system shall be measured per set with required length and shall include all items as given in the schedule of quantities. Painting shall be included in rate of headers.

ii. CPVC pipes between various filters and units shall be measured per linear meter of the finished length and shall include all fittings, flanges, jointing, clamps for fixing to walls or hangers and testing. Flanges shall include 3 mm thick insertion rubber gasket, nuts, bolts and testing.

iii. Vibration eliminators, “Y” strainers, butterfly valves, slim non return valves, ball valves shall be measured by numbers and shall include all items as given in the schedule of quantities and specifications except from pump room.
Chapter 4

TECHNICAL SPECIFICATIONS - HORTICULTURE WORKS

1. **Scope of work**
The work shall in general conform to the Latest CPWD Specifications for works. Work under this Contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required. The Contractor is required to completely furnish all the plumbing and other specialized services as described hereinafter and as specified in the schedule of quantities for Horticulture works.

2. **Excavation**
The top excavated soil shall be collected, stacked, preserved for use in landscaping / horticulture works. Surplus top excavated soil may be given to the nurseries or put to use in other Horticulture works.

3. **GRASSING**

   **Preparation**
   
i. During period prior to planting the ground shall be maintained free from weeds.

   ii. Grading and final leveling of the lawn shall be completed at least three weeks prior to the actual sowing. Clods of excavated earth shall then be broken up to the size not more than 75mm in any direction. The area shall then be flooded with water and after 10 days and within 15 days of flooding, weeds that re-germinate shall be uprooted carefully. The rubbish arising from this operation shall be removed and disposed of in a manner directed by Engineer. Regular watering shall be continued until sowing by dividing the lawn area into portion or approx 5 mts. Square by constructing small bunds to retain water. These ‘bunds’ shall be level just prior to sowing of grass plants. At the time of actual planting of grass, it shall be ensured that the soil has completely settled.

   iii. Slight unevenness, ups and downs and shallow depressions resulting from the settlement of the flooded ground, in drying and from the subsequent weeding operations, shall be removed by fine dressing the surface to the final levels by adding suitable quantities of good earth brought from outside, if necessary as directed by the Engineer. In fine dressing, the soil at the surface and for 40mm depth below shall be broken down to particles of size not exceeding 6mm in any direction.

   **SOIL**: The soil itself shall be ensured to satisfaction of Engineer to be a good, fibrous loam, rich in humus.

   **SOWING THE GRASS ROOTS**

   i. Grass roots (Cynodon Dectylon or a local approved by the Engineer) shall be obtained from a grass patch, seen and approved beforehand.

   ii. The grass roots stock received at site shall be manually cleaned of all weeds and water sprayed over the same after keeping the stock in a place protected from sun and dry winds.
iii. Grass stock received at site may be stored for a maximum of three days. In case grassing for some areas is scheduled for a later date fresh stock of grass roots shall be ordered and obtained.

**EXECUTION:**

i. Small roots shall be debbled about 15 cms (or at other spacings as per BOQ item) apart into the prepared grounds. Dead grass and weeds shall not be planted.

ii. Grass areas will only be accepted as reaching practical completion when germination has proved satisfactory and all weeds have been removed.

iii. All planting is to be done in moderately dry to moist (not wet) soil and at times when wind does not exceed a velocity of 8 kilometer per hours.

**MAINTENANCE OF LAWN**

i. As soon as the grass is approximately an inch high it shall be rolled with a light wooder, roller in fine, dry weather and when it has grown to 2 to 3 inches above the ground, weeds must be removed and regular cutting with the scythe and rolling must be begun. A top dressing of annouce of guano to the square yard on well decomposed well broken sludge manure will help on the young grass. The scythe must continue to be used for several months until the grass is sufficiently secure in the ground to bear the mowing machine. It should be possible to use the inch above the normal level of the first two or three cuttings. That is to day the grass should be cut so that it is from 1 to 2 inches in length, instead of the ½ to ¾ of an inch necessary for mature grass.

ii. In absence of rain the lawn shall be watered every ten days heavily, soaking the soil through to a depth of at least 25 cms.

iii. Damage failure or dying back of grass due to neglect of watering especially for seeding out of normal season shall be the responsibility of the contractor.

iv. Any shrinkage below the specified levels during the contract or defects liability period shall be rectified at the contractor's expense.

v. The contractor is to exercise care in the use of rotary cultivator and mowing machines to reduce to a minimum the hazards of flying stones and brickbats. All rotary mowing machines are to be fitted with safety guards.

**ROLING:** A light roller shall be used periodically, taking care that the lawn is not too wet and sodden. Rolling should not be resorted to, to correct the levels in case certain depressions are formed due to watering

**EDGING:** The contractor shall establish a neat edge where planting areas meet grass areas with spade or edging tool immediately after all planting, including lawn planting, is completed. Particular care shall be exercised in edging to establish good flowing curves as shown on the plans or as directed by the Engineer. Edging must be cut regularly and shall be maintained by the contractor.

**FERTILIZING:** The lawn shall be fed once a month with liquid manure prepared by dissolving 45 grams of ammonia sulphate in 5 litres of water.

**WATERING:** Water shall be applied daily during dry weather. Watering whenever done should be thorough and should wet the soil at least up to a depth of 20 cms to eliminate air pockets and settle the soil.
WEEDING: Prior to regular mowing the contractor shall carefully remove rank and unsightly weeds.

4. MAINTENANCE: The landscape contractor shall maintain all planted area within the landscape contract boundaries until the period of one year after the complete plantation. Maintenance shall include replacement of dead plants. Watering, weeding, cultivating, control of insects, fungicide and other disease by means of spraying with an approved insecticide or fungicide, pruning and other horticulture operations necessary for the proper growth of the plants and for keeping the landscape sub-contract area neat in appearance.

5. PRUNING & REPAIRS: Upon completion of planting work on the landscape sub-contract all trees should be pruned and all injuries repaired where necessary. The amount of pruning shall be limited to the minimum necessary to remove dead or injured twigs and branches and to compensate for the loss of roots and the results of transplanting operations. Pruning shall be done in such a manner as not to change the natural habit or special shape of the trees. In general, one third to one fourth branching structure of the plants to be removed to compensate the loss of roots during transplantation by thinning or shortening branches but no leaders shall be cut. All pruning shall be done with sharp tools in accordance with instructions of the HITES. Pruning cuts shall be painted with recommended paints.

6. TREE GUARDS: Where tree guards are necessary, care should be taken to ensure that they do not impede movement or restrict growth.

7. NURSERY STOCK: Planting should be carried out as soon possible after reaching site. Where planting must, of necessity, be delayed, care should be taken to protect the plants from pilfering or damage from people or animals. Plants with bare roots should be healed in as soon as received or otherwise protected from dying out, and others set closely together and protected from the wind. If planting should be unpacked, the bundles opened up and each group of plants heeled in separately and clearly labeled. If for any reason the surface of the roots becomes dry the roots should be thoroughly soaked before planting.

8. PROTECTIVE FENCING: According to local environment shrubs may have to be protected adequately from vandalism until established.

9. COMPLETION: On completion the ground should be formed over and left tidy.

10. RATE: The rates quoted for the horticulture items listed in BOQ shall provide for the cost involved in all the operations described above.
CHAPTER - 5
SPECIAL CONDITIONS FOR ELECTRICAL SERVICES

1.0 GENERAL
The design and workmanship shall be in accordance with the best engineering practices, to ensure satisfactory performance and service life. The requirement offered by the contractor shall be complete in all respects. Any materials or accessories which may not have been specifically mentioned, but which are usual and necessary for the satisfactory and trouble free operation and maintenance of the equipment shall be provided without any extra cost of the purchaser. This shall also include spares for commissioning of the equipment.

2.0 The contractor shall obtain all sanctions (electrical loads, approval of drawing/ESS/D.G.’s estimator/approval of meter room etc.) from the concerned authorities and permits required for the electrical installation work. All actual fee payable in this regard will be reimbursed against receipt/documentary evidence. On completion of work, the contractor shall obtain NOC from SEB & Director of Safety of the concerned state; a copy of the same shall be delivered to HITES. Contractor shall be responsible for handing over to SEB and other authorities shall be responsibility of contractor till commissioning and getting electricity in the complex.

The HITES shall have full power regarding the materials or work got tested by independent agency at the electrical contractor's expenses in order to prove their soundness and adequacy. The contractor will rectify the defects/suggestions pointed out by HITES/independent agency at his own expenses.

The installation shall comply in all respects with the requirements of Indian Electricity Act 1910, Indian Electricity Rules (IER) 1956 and other related Laws and Regulations as amended up to date, thereunder and special requirements, if any, of the State Electricity Boards etc. The bidder is liable to furnish the list of authorized licensed persons/employed/deputed to carry out the works/perform the assigned duties to fulfill the requirement of Rule No.3 of IER 1956 as amended up to date.

3.0 DRAWINGS
i) The list of drawings along with these specifications is given in Annexure. These drawings are meant to give general idea to bidder regarding the nature of work covered by these specifications.

ii) Any information/data shown/not shown in these drawings shall not relieve the contractor of his responsibility to carry out the work as per the specifications. Additional information required by the bidder/tenderer for successfully completing the work shall be obtained by him.

iii) Shop Drawings
The contractor shall prepare detailed coordinated electrical shop drawing indicating lighting/lighting fixtures, convenience outlets, D.G.’s, H.T., Transformer, M.V. Panel Boards/Relay Panel, PCC, DB’s, Rising Mains, Cable Schedule with other relevant services and submit to the HITES for approval or the Engineer-in-Charge before commencing the work. The shop drawings shall indicate all setting out details and physical dimensions of all components with wiring and cable details including system operating write up in the system i.e. 11 KV Panel Board, Control and Relay Panel
iv) Completion Drawings/As Built Drawings

On completion of the work and before issue of certificate of virtual completion, the contractor shall submit to the HITES 4 sets along with soft copy of ‘As Built’ drawings (in AutoCAD & PDF format) of the work along with 01 Nos. cloth tracing originals including write up (trouble shooting, installation, operation and maintenance manual with instructions) incorporating all such changes and modifications during engineering and execution along with warrantee & guarantee certificates from manufacturers.

These drawings must provide:

- Run and size of conduit, inspection and pull boxes including routing and locations.
- Number and size of conductor in each conduit.
- Locations and rating of sockets and switches controlling the light and power outlet.
- A complete wiring diagram as installed and schematic drawings showing all connections in the complete electrical system.
- Location of outlets of various services, junction boxes, light fixtures.
- Location of all earthing stations route and size of all earthing conductors.
- Layout and particulars of all cables.
- Location and details of PCC’s, MCC’s, Feeder Pillars, capacitor control panels, PLC D.G. set panel, UPS panel, and relay panels with description detailed control wiring diagram.
- Location of transformer and its details and control wiring diagram.
- Location of Hume pipe and manhole including HT/LT cable layout and scheduling.
- Location of D.G.’s, exhaust and auxiliary equipment with schematic drawings.
- Layout of cable trays with support and their fixing details.
- Location of all earthing station, route and size of all earthing conductor.
- Layout and particulars of rising mains with fixing details.

v) Position of HT/LT Switch Boards/Transformer & D.G.’S

The recommended position of the switch boards, transformer & D.G.’s as shown on the layout drawings will be adhered to as far as practicable.

The contractor shall submit 2 sets of samples of each type of accessories and apparatus, proposed to be used in the installation at site for approval (drawings or samples) as required shall be submitted by contractor and the choice of selection out of the approved list lies with the HITES. For all non-specified items, approval of the HITES shall be obtained prior to procurement of the same. HITES shall in no way be liable for
rejection of the any material due to poor quality, poor workmanship, poor material etc.

4.0 MANUFACTURER’S INSTRUCTIONS

Where manufacturers have furnished specific instructions, relating to the material/equipment to be used on this job, covering points not specifically mentioned in this document, manufacturers’ instructions should be followed.

5.0 MATERIALS AND EQUIPMENT

All the materials and equipment shall be of the approved make and design. Unless otherwise called for any approval by HITES’s Engineer-in-Charge, only the best quality materials and equipment shall be used.

The contractor shall fill in the data sheet for capital equipment as attached elsewhere in this document. The Material/Equipment shall be rejected due to not giving / filling in the details of the said equipment.

6.0 GENERAL DETAILS

6.01 Space Heaters & Lighting.

One of more adequately rated heaters thermostatically controlled with On-Off switch and fuse shall be provided to prevent condensation in any panel compartment. The heaters shall be installed in the lower portion of the compartment and electrical connections shall be made from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation. CFL lamp shall be provided in any panel compartment.

6.02 Fungistatic Varnish

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts, which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

6.03 Ventilation Opening

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

6.04 Degree of Protection

The enclosures of the Control Cabinets, Junction Boxes and Marshalling Boxes, Panels etc. to be installed shall provide degree of protection as called for in specification / BOQ whenever it is not mentioned it shall be as given below.

- Installed out door: IP-55.
- Installed indoor in air-conditioned area: IP-52.
- Installed in covered area: IP-52.
• Installed indoor in non-air-conditioned area where possibility of entry of water is limited: IP-42.

• For L.T. switchgear (AC and DC distribution boards): IP-52.

The degree of protection shall be in accordance with IS: 13947 (Part-I)/IEC-947 (Part-I).

Type test report for degree of protection test, on each type of the box shall be submitted for approval.

6.05 Rating Plates, Name Plates and Labels

Main PCC, PCC’s, MDB and auxiliaries items installed in the building are to permanently attach to it in a conspicuous position. A rating plate of non-corrosive material with engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of the loading conditions of equipment in question has been designed to operate and such diagram plates as may be required by the purchaser. The rating plate of each equipment shall be according to IEC requirement.

All such nameplates, instruction plates, rating plates shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates one with Hindi and the other with English inscriptions may be provided.

6.06 First Fill of Consumables, Oil and Lubricants

All the first fill of consumables such as oils, lubricants, filling compounds, touch up paints, welding/soldering/brazing material for all copper/G.I. earthing and essential chemicals etc. which will be required to put the equipment/scheme covered under the scope of the specifications, into successful operation, shall be furnished by the Contractor unless specifically excluded under the exclusions in these specifications and documents.

7.0 DESIGN IMPROVEMENTS

The bidder shall note that the equipment offered by him in the bid only shall be accepted for supply. If for any reason, Contractor wishes to deviate from specification, prior permission from HITES will be sought.

If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly in the specification.

8.0 QUALITY ASSURANCE PROGRAMME

To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Contractor’s works or at his sub-contractor's premises or at the Purchaser's site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be outlined by the Contractor and shall be finally accepted by the Purchaser after discussions before the award of Contract. A quality assurance programme of the contractor shall generally cover the following:

• His organization structure for the management and implementation of the proposed quality assurance programme.
- Documentation control system.
- Qualification data for bidder’s key personnel.
- The procedure for purchases of materials, parts components and selection of sub-contractor’s services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
- System for shop manufacturing and site erection controls including process controls and fabrication and assembly control.
- Control of non-conforming items and system for corrective actions.
- Inspection and test procedure both for manufacture and field activities.
- Control of calibration and testing of measuring instruments and field activities.
- System for indication and appraisal of inspection status.
- System for quality audits.
- System for authorizing release of manufactured product to the Purchaser.
- System for maintenance of records.
- System for handling storage and delivery.
- A quality plan-detailed out the specific quality control measures and procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered.

The Purchaser or his duly authorized representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor/his Vendor’s quality management and control activities.

9.0 QUALITY ASSURANCE DOCUMENTS

The Contractor shall be required to submit the following Quality Assurance Documents within three weeks after dispatch of the equipment.

- All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication and reports including radiography interpretation reports.
- Welder and welding operator qualification certificates.
- Welder’s identification list, listing welders and welding operator’s qualification procedure and welding identification symbols.
- Raw material test reports on components as specified by the specification and/or agreed to in the quality plan.
- Stress relief time temperature charts/oil impregnation time temperature charts.
- Factory test results for testing required as per applicable codes/mutually agreed quality plan/standards referred in the technical specification.

The quality plan with verification of various customer inspection points (CIP) as mutually and methods used to verify the inspection and testing points in the quality plan were performed satisfactorily.

10.0 INSPECTION, TESTING AND INSPECTION CERTIFICATE
• The HITES or duly authorized representative shall have at all reasonable times free access to the Contractor/Manufacturer’s premises or works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection, if part of the works is being manufactured or assembled at other premises or works, the Contractor shall obtain permission to inspect as if the works were manufactured or assembled on the Contractor’s own premises or works. Inspection may be made at any stage of manufacture, dispatch or at site at the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

• All equipment being supplied shall conform to type tests and shall be subject to routine tests in accordance with requirements stipulated under respective sections. Bidder shall submit the type tests reports for approval. The Contractor shall intimate the HITES the detailed programme about the tests at least three (3) weeks in advance in case of domestic supplies. If for any item type test is pending payment would be made on successful completion of type/routine test(s) actually carried out as per HITES instructions.

• The Contractor shall give the HITES thirty (30) days written notice of any material being ready for testing. Such tests shall be to the Contractor’s account. The HITES, unless witnessing of the tests is virtually waived off, will attend such tests within thirty (30) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed with the test which shall be deemed to have been made in the presence of HITES and he shall forthwith forward to the HITES duly certified copies of tests in triplicate.

• The HITES shall within fifteen (15) days from the date of inspection as defined shall inform in writing to the Contractor of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and make the necessary modifications accordingly.

• When the factory tests have been completed at the Contractor’s or Sub-contractor’s works, the HITES shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the HITES, the certificate shall be issued within fifteen (15) days of receipt of the Contractor’s Test certificate by the HITES. Failure of the issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificate shall not bind the HITES to accept the equipment should, it, on further tests after erection, is found not to comply with the Specification. The equipment shall be dispatched to site only after approval of test reports and issuance of clearance by the HITES.

• The contractor shall arrange all necessary instruction and testing facilities free of cost for this purpose including air travel, lodging and boarding expenses.

• For tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be required by HITES or this authorized representative to carry out effectively such tests of the equipment in accordance with the Specification.
• The inspection by HITES and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract.

• The HITES will have the right of having at his own expenses any other tests(s) of reasonable nature carried out at Contractor’s premises or at site or in any other place in addition of aforesaid type and routine tests to satisfy that the material comply with the specifications.

• The HITES reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipment for these tests shall be provided by the Contractor.

11.0 TESTS

11.01 Charging

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the HITES and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The pre-commissioning tests to be performed as per relevant I.S. given and shall be included in the Contractor’s quality assurance programme.

11.02 Commissioning Tests

• The available instrumentation and control equipment will be used during such tests and the Contractor will calibrate all such measuring equipment and devices as far as practicable. However, unmeasurable parameters shall be taken into account in a reasonable manner by the Contractor for the requirement of these tests. The tests will be conducted at the specified load points and as near the specified cycle condition as practicable. The Contractor will apply proper corrections in calculation, to take into account conditions, which do not correspond to the specified conditions.

• All instruments, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.

• Pre-commissioning test shall be carried out as per relevant IS and/or as specified in the relevant clause.

• The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning of the equipment. However necessary fee shall be reimbursed by DGHS on production of requisite documents.

12.0 PACKAGING

All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of availability of Railway wagon/truck/trailer sizes in India should be taken account of the Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. HITES takes no responsibility of the availability of any special packaging/transporting
arrangement.

13.0 PROTECTION

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

14.0 FINISHING OF METAL SURFACES

14.01 General

All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts and bolts and spring washers shall be electro galvanized. All steel conductors used for earthing/grounding (above ground level) shall be galvanized according to IS: 2629.

14.02 Hot Dip Galvanizing

- The minimum weight of the zinc coating shall be 700 gm/sq.m and minimum thickness of coating shall be 85 microns.
- The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discolored patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.
- After galvanizing drilling or welding shall be performed on the galvanized parts of the earthing materials. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.
- The galvanized steel shall be subjected to six one minute dips in copper sulphate solution as per IS-2633.
- Sharp edges with radii less than 2.5mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Indian Standards.
  - Coating thickness,
  - Uniformity of zinc,
  - Adhesion test,
  - Mass of zinc coating.
- Galvanized material must be transported properly to ensure that galvanized surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

14.03 Painting
All sheet steel work shall be degreased, pickled, phosphate in accordance with the IS-6005 “Code of practice for phosphating iron and sheet”. All surfaces which will not be easily accessible after shop assembly shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, staving type zinc chromate primer. The first coat may be “flash dried” while the second coat shall be shaved.

Powder coating/electrostatic painting of approved shade shall be applied.

The exterior color of the paint shall be as per shade no.697 of IS-5 or as approved by Engineer-in-charge and inside shall be white or as approved by Engineer-in-charge. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments, if required.

In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures like electrostatic painting etc. the procedure shall be submitted along with the Bids for HITES’s review and approval.

15.0 HANDLING, STORING AND INSTALLATION

In accordance with the specific installation instructions as shown on manufacturer’s drawings or as directed by the Purchaser or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented.

Contractor shall follow the unloading and transporting procedure at site, as well as storing, testing and commissioning of the various equipment being procured by him separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer’s Engineer(s) and shall extend full co-operation to them.

In case of any doubt/ misunderstanding as to the correct interpretation of manufacturer’s drawings or instructions, necessary clarifications shall be obtained from theHITES. Contractor shall be held responsible for any damage to the equipment consequent for not following manufacturer’s drawings/instructions correctly.

Where assemblies are supplied in more than the one section, Contractor shall make all necessary connections between sections. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.

The Contractor shall submit to the HITES every week, a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site.
Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

- The Contractor shall be fully responsible for the equipment/material until the same is handed over to the HITES in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by HITES, as well as protection of the same against theft, element of nature, corrosion, damages etc.
- The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment, which require indoor storage.
- The words ‘erection’ and ‘installation’ used in the specification are synonymous.
- Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.
- The minimum phase to earth, phase to phase and section clearance along with other technical parameters for the various voltage levels shall be maintained as per relevant IS.

16.0 PROTECTIVE GUARDS

Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards with necessary spares and accessories shall be designed for easy installation and removal for maintenance purpose.

17.0 DESIGN CO-ORDINATION

The Contractor shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

18.0 DESIGN COORDINATION MEETING

The Contractor will be called upon to attend design co-ordination meetings with the Engineer, and the HITES/DGHS during the period of Contract. The Contractor shall attend such meetings at his own cost at New Delhi or at mutually agreed venue as and when required and fully co-operate with such persons and agencies involved during those discussions.

19.0 TOOLS AND TACKLES

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dis-assembly and maintenance of the equipments.

20.0 Polycarbonate Sheet Roofing

DPI system, a complete assembly of extruded cellular structure UV protected polycarbonate panels incorporated into a complete system. Co-extruded UV protected polycarbonate panel system of minimum 12 mm thickness with panel width of 600 mm to ensure best performance for wind uplift, vibration, oil canning and visual appearance. Panels shall be manufactured with vertical standing seam with standing seam height of 10 - 15mm at both sides of the panel. Panels shall be of Softlite / Antiglare type to prevent glare. Panels shall be fixed on purlins with the Z - Type Stainless Steel
Fastener/retention clips and connectors. Each fastener shall be min 1 mm thick of SS 304 Grade and secured to supporting frame/structure with min 3 numbers self-drilling screws so that the Pull-Out Load of Fastener exceeds 7000 N (7 `KN) when tested as per ISO 6892:1998 and IS 1608: 2005. Snap-on connectors to interlock the panels shall have 2-4 teeth grip-lock locking mechanism to ensure maximum uplift capability. Polycarbonate panels also shall not have Yellowness Index as per ASTM D 1925 of 15 units when tested on a sample exposed to UV for 500 Hours as per ASTM G 155. The polycarbonate panels must satisfy Dart drop impact test as per IS 14443-97 shall show no sign of breakage on Polycarbonate sheets which have been exposed to UV for a min. of 500 Hours as per ASTM G 155. Panel shall be with additional End cap/Aluminum U / F Profile / Glazing Bar (mill finish) for ends as required. Panel shall be fixed over M S structural steel / MS purlin (paid separately) conforming to the detail technical specifications as per approved architectural drawings. The work shall be carried out as approved and complete up to the satisfaction of Engineer in Charge.
CHAPTER - 6

TECHNICAL SPECIFICATIONS FOR ELECTRICAL SERVICES-

GENERAL REQUIREMENTS

1 GENERAL

To provide a complete electrical system for the distribution of electric power from the point of HT power supply and DG Sets upto the utilization equipment, as shown in the drawings and described in these specifications. The quantities mentioned in BOQ are tentative. It will be the bidder’s responsibility to work out the exact quantities from drawings or from work site.

2 SCOPE

The bidder shall supply, install, test and commission along with requisite spare, maintenance tools and tackles the following equipment and system in the Project. The scope also covers the detailed engineering and calculations of the various equipment/system mentioned hereunder and the same shall be approved by the HITES/Engineer-in-charge prior to execution of the job.

(i) 11 KV H.T. Switchboards.
(ii) 11 KV Transformers
(iii) Medium voltage switchgear.
(iv) Battery and battery charger.
(v) Earthing.
(vi) Lightning protection system.
(vii) Capacitor with control panels.
(viii) Synchronization and AMF pane.
(ix) Laying and termination of H.T. cables.
(x) Laying and termination of L.T. cables.
(xi) Conduiting for Fire Alarm and Public Address System
(xii) Busduct / Rising Main / Distribution Boards / Sub-Distribution Board.
(xiii) Complete internal building wiring as per specification.
(xiv) Safety to personnel and equipment during both operation and maintenance.
(xv) Reliability of Service.
(xvi) Minimum fire risk.

(xvii) Ease of maintenance and convenience of operation.

(xviii) Automatic protection of all electrical equipment through selective relaying system.

(xix) Electrical supply to equipment and machinery within the design operating limits.

(xx) Adequate provision for future expansion and modification.

(xxi) Maximum interchange ability of equipment.

(xxii) Fail-safe feature.

(xxiii) Suitability for applicable environmental factors.

This specification defines the basic guidelines to develop a suitable electrical system as necessary for the commercial complex. All data required in this regard shall be taken into consideration to develop a detailed engineering of the system. Site conditions as applicable are mentioned elsewhere.

Compliance with these specifications and/or approval of any of the Contractor’s documents shall in no case relieve the Contractor of his contractual obligations.

All work to be performed and supplies shall be affected as a part of contract requires specific approval/ review of HITES or his authorised representative. Major activities requiring approval/ review shall include but not be limited to the following:

The engineering activities shall comprise the submission for approval of the following:

(xxiv) Basic engineering documents e.g. overall single line diagram, area classification drawing, overall cable layout, testing, type test report, guaranteed particulars of all equipment and maintenance manuals.

(xxv) Quality assurance procedures.

(xxvi) Field testing and commissioning procedures.

(xxvii) Basic engineering calculations viz. load analysis; load flow, fault level calculations, and voltage drop calculations during motor start-up/re-acceleration etc.

(xxviii) Control and protection schemes.

(xxix) Load sharing and annunciation scheme,

(xxx) Sizing calculation for cable trays/cable trenches.

(.xxxi) Area-wise illumination level calculation and preparation of power supply distribution drawing.
(xxxii) Calculation for earthing system and lightning protection.

**The Contractor shall be responsible for:**

(这家伙) Detailed co-ordination with other services, shop drawings for various electrical layouts such as equipment layout, lighting layouts, cabling layouts, earthing and lightning protection layouts, including equipment installation and cable termination details etc. prior to start of work.

(家伙) Preparation of bill of materials for cabling, lighting, earthing and miscellaneous items etc.

(家伙) Cable schedule.

(家伙) Lighting/power panel schedule.

(家伙) Interconnection drawing.

(家伙) Protection co-ordination drawings/tables for complete power system.

(家伙) Shop inspection and testing procedures.

(xl) Field testing and commissioning procedures.

(xli) Preparation of as built drawings for all services.

(xlii) Any other work/activity which is not listed above however is necessary for completeness of electrical system.

3 **CODES & STANDARDS**

The design engineering manufacturing and the installation shall be in accordance with established codes, sound engineering practices, and specifications and shall conform to the statutory regulations applicable in the country. Contractor shall obtain all approvals from statutory authorities e.g. Electrical inspector, pollution control boards, SEB as applicable before commissioning of electrical/DGs.

(xliii) Indian Electricity Act.

(xliv) Indian Electricity Rules.

(xlv) Factory Act.

(xlvi) Pollution Control Act.

**IS-732:** Code of practice for electrical wiring installation system voltage not exceeding 650V.

**IS-3043:** Earthing.
IS-2309: Code of practice for the protection of buildings and allied structure against Lightning

IS-7689: Guide for control of undesirable static electricity.

IS-3716: Insulation co-ordination application guide.

IS-8130: Conductors for insulated electrical cables and flexible cords.

IS-5831: PVC insulation and sheath of electric cables.

IS-3975: Mild steel wire, strips & tapes for armouring cable.

IS-3961: Current rating of cables

IS-694: PVC insulated (heavy duty) electric cables for working. Voltage up to and including 1100 volts.

IS-424- 1475 (F-3): Power cable flexibility test.

IEC-439/IS-7098: Specification for cross linked polyethylene insulated PVC sheathed cable for working voltage up to 1.1 KV.

IS-1554: PVC insulated cables up to 1100 volts.

IS-10810: Test procedures for cables.

IS-6121: Cable glands.

IS-10418: Cable drums.

IEC-754(1): FRLS PVC insulated cable.


ASTM-D-2843: Standard test method for measuring the density of smoke from burning or decomposition.


IEEE-383: Standard for type test class-IE, electric cables, field splicers and connections for power generation station.

IS 13947/IEC 947: Air circuit breaker/moulded case circuit breaker.

IS-8623: Specification for factory built assemblies of switch gear and control gear for voltage upto and including 1000vac/1200vdc

IS 1018: Switchgear and control gear selection/installation and maintenance
IS-1248: Direct acting indicating analogue electrical measuring instruments and testing accessories.

IS-13779: Digital measuring instruments and testing accessories.

IS-3156: Voltage transformer

IS-2705: Current transformer for metering and protection with classification burden and insulation.

IS -2147: Degree of protection provided by enclosures for low voltage.

PART I, II,III  Switchgear and control gear

IS-3427: Metal enclosed switchgear and control gear

BS-162: Safety clearance


IS-375: Marking and arrangement for switchgear, bus bars, main connections and auxiliary wiring.

IS-722: Ac electric meters

IS-3231 /IEC-255: Electrical relays for power system protection.

IS-5082: Electrolytic copper/aluminium bus bars

IS-2834: Capacitors

IS-2713: Steel tubular pole

IS-335: Specification for insulating oil

IS-3837: Specifications for accessories for rigid steel conduit for electrical wiring.

IS-11171:1985/

IEC 60726/IS 2026/

IS1180: Distribution Transformer

(PART I, II, III) GI/STEEL /PVC conduit pipe for electrical wiring.

IS-2274: Code of practice for electrical wiring installation system voltages exceeding 650 volts.

IS-6665: Code of practice for industrial lighting

IS-3646: Interior insulation part 1&2

IS-7752: Guide for improvement of power factor consumer's installation.

IS-13346: General requirement for electrical for explosive gas atmosphere.

IS-13408: Code of practice for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres

IS-12360: Voltage and frequency for ac transmission & distribution system.

IS-5572: Classification of hazardous area for electrical installations.

IS-5571: Guide for selection of electrical equipment for hazardous area.

IS-4201: Application guide for Current Transformer

IS-4146: Application guide for Voltage Transformer

IS-10028: Code of practice for installation and maintenance of transformer

IS-8478: Application guide for on load tap changer

IS-10561: Application guide for power transformer

IS-1646: Code of practice for fire safety of buildings electrical installation

IS-3034: Code of practice for fire safety of industrial building-electrical generating and distribution station

IP-30: National electrical code (NEC) BIS publication.

IS-4722: Rotating electrical machines.

IS-4889: Method of determination of efficiency of rotating electrical machines.

IS-325: Three phase induction motors.

IS-4729: Measurement and evaluation of vibration of rotating electrical machines.

IS-900: Installation and maintenance of induction motors.

IS-4029: Air break switches.

IS-2208-9224: HRC cartridge fuses.

IS-2959: Contactors.

IS-9537: Rigid steel conduit.

IS-1601/BS-649: Performance & testing of Internal Combustion (IC) engines for general purpose.

AIEE-606(1959): Recommended specification for speed governing of I.C. engine generator units.

BS-5514/IS-3046 8528(Part-2): Reciprocating IC engine driven A.C. generators.

Any other standard may be followed provided it is equivalent or more stringent than the standards specified above.

**DESIGN CRITERIA**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>I Electrical Details of Incoming Supply</strong></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>Fault level (sym.) at supply of point (designed)</td>
<td>350 MVA (to be confirmed from State Electricity Board by Tenderer).</td>
</tr>
<tr>
<td>b</td>
<td>Neutral Earthing</td>
<td>Solid Earthing</td>
</tr>
<tr>
<td>c</td>
<td>Voltage Regulation</td>
<td>± 10%</td>
</tr>
<tr>
<td>d</td>
<td>Frequency Regulations</td>
<td>± 3%</td>
</tr>
<tr>
<td>e</td>
<td>Combined</td>
<td>± 10%</td>
</tr>
<tr>
<td></td>
<td><strong>II L.T. Power Distribution Systems</strong></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>Voltage</td>
<td>15 V / 240 V</td>
</tr>
<tr>
<td>b</td>
<td>Frequency</td>
<td>0 Hz</td>
</tr>
<tr>
<td>c</td>
<td>Neutral Earthing</td>
<td>rounded</td>
</tr>
<tr>
<td>d</td>
<td>Short Circuit Fault withstand Capacity</td>
<td>10 KA - 50 KA (1 Sec.) as per B.O.Q. and specification.</td>
</tr>
<tr>
<td></td>
<td><strong>III Emergency Lighting (Battery Operated With Self Charger)</strong></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>Voltage</td>
<td>2 V, DC</td>
</tr>
<tr>
<td>b</td>
<td>Source</td>
<td>Mains/D.G. Set</td>
</tr>
<tr>
<td></td>
<td><strong>IV Control Supply for Electrical System</strong></td>
<td>The various supply voltage to be used in the control panels for main equipment are</td>
</tr>
<tr>
<td>a</td>
<td>Spring Charge Motor</td>
<td>30 Volt A/C</td>
</tr>
<tr>
<td>b</td>
<td>Closing/Trip Coil</td>
<td>4 V DC / 230V AC</td>
</tr>
</tbody>
</table>
c Alarm/Indication/Relay 4 V DC/230 V AC

d Heaters 30 V AC

V Power Supply Load Control/Distribution Panel. 433 V TPN / 240 V 1 phase A.C. (other supply if required shall be derived by package vendor)

VI Painting of Panel. Powder coating of approved shade

VII Painting of Cable Tray & Structure Steel. Powder coated of approved shade

I Electrical Details of Incoming Supply

a Fault level (sym.) at supply of point (designed) 350 MVA (to be confirmed from State Electricity Board by Tenderer).

b Neutral Earthing Solid Earthing

c Voltage Regulation ± 10%

d Frequency Regulations ± 3%

e Combined ± 10%

II L.T. Power Distribution Systems

a Voltage 15 V / 240 V

b Frequency 0 Hz

c Neutral Earthing rounded

d Short Circuit Fault withstand Capacity 10 KA - 50 KA (1 Sec.) as per B.O.Q. and specification.

III Emergency Lighting (Battery Operated With Self Charger)

a Voltage 2 V, DC

b Source Mains/D.G. Set

IV Control Supply for Electrical System: The various supply voltage to be used in the control panels for main equipment are

a Spring Charge Motor 30 Volt A/C

b Closing/Trip Coil 4 V DC / 230V AC

c Alarm/Indication/Relay 4 V DC/230 V AC
In case of any deviation /conflict of this specification with the codes & standards, the following order of precedence shall govern.

a) Specification, particular specification if any, and drawings.

b) Indian regulations/codes and standards.

4 SITE CONDITIONS

i) Design ambient  50 Deg.C. Maximum, 2 Deg. C. minimum

ii) Relative Humidity  85% maximum

iii) Site environment  Normal

DESIGN CRITERIA

5 CABLE DETAILS

Internal Wiring. Copper conductor PVC insulated 1.1 KV grade as called for in BOQ.

Power Cables (L.T.) XLPE insulated Al. Armoured Cable as per BOQ.

11 KV. Aluminium conductor XLPE insulated armoured cable.

Grounding Conductor. Copper/G.I. strip as per BOQ.

Lightning Conductor. G.I. Strip.

6 ACCURACY CLASS OF METERS

a Revenue Metres. Class-0.5 or as per SEB approved.

b Ammeter, Voltmeter and Other Instruments. Class – I Digital / Analogue as per BOQ.
SECTION –1: 11KV VCB SWITCHGEAR

1.1. 11KV VCB SWITCHGEAR

i. GENERAL:

Vacuum Circuit Breaker shall be incorporated in HT Panel boards in required combination of incoming panels, coupler panel, outgoing transformer panels & outgoing feeder panels. VCB’s shall conform to IEC 298 and 694, IS 3427, BS 5227 and VDE 0670, Part 6 as well as the regulations mentioned therein. VCB’s shall be indoor type & suitable for operation on 11 kV, 3-Phase, 50 Hz AC supply. Metering and protection in the panels as detailed herein after. All VCBs shall be compatible to BMS System.

ii. TYPE AND CONSTRUCTION:

The metal clad panel shall be fully extensible and compartmentalized to give.

a. Circuit Breaker Compartment

b. Busbar Compartment

c. CT and Cable Compartment

iii. The compartments shall be safe to touch and compartments thus formed shall be dust proof & vermin proof. A separate metering chamber for fixing the necessary instrumentation metering and protective equipment shall be provided panel on the front.

iv. The VCB shall consist of three air insulated poles incorporating mechanism of interrupters. The body of interrupters shall be made of nickel chromium steel supported on insulators made out of metalised aluminum oxide. The contacts shall be of chromium copper and butt shaped.

v. Vacuum Circuit Breaker shall be mounted on truck or a carriage mechanism. In case of truck mechanism, the breaker shall be on a trolley while in a carriage mechanism, shall be separate door and it shall be possible to perform all operations with front door closed. The draw out carriage shall have two positions for the circuit breaker viz isolated/test & service position. Bus bars shall be insulated type made of high conductivity copper supported on cast epoxy monobloc designed to withstand full short circuit currents and shall be provided all along the length of the HT Board.

vi. It shall be horizontal isolation, horizontal draw out type, fully interlocked, with dust and vermin proof construction, suitable for indoor instillation. The panel shall be supplied with the manufacturer’s test certificates.
vii. The steel work should have undergone a rigorous rust proofing process comprising alkaline degreasing, descaling in dilute sulphuric acid and recognized phosphate process and shall then be given power coating (Electrostatic) paint of manufacturer’s standard shade.

viii. The switchgear constructions shall be such that breaker operation and internal explosions do not endanger the operating personnel, and the front of the panel shall be specially designed to withstand these. Pressure relief flaps shall be provided for safely venting out gases produced inside the high voltage compartment, bus bar compartment and termination compartment. These flaps shall be vented upwards and cannot be opened from outside. These relief flaps shall be of such construction as not to permit ingress of dust/water in harmful quantities under normal working conditions. Enclosure shall be constructed with sheet steel of at least 2.0 mm thickness. It shall have a rigid, smooth, leveled, flawless finish.

ix. Voltage transformer of burden not less than 100 VA and of proper ratio as specified shall be provided. The accuracy class for the VT shall be 0.5 as per is 3156 Part 1 to III for incomer and class I for outgoing panels. The PT shall be of cast epoxy resin construction. It shall be withdrawable type. HRC fuses circuit Breaker shall be provided on both HV and LV side. Adequate space at the rear of the panel shall be provided for the termination of power & control cables. The panel shall be provided with suitable terminating arrangement for the termination of cables. Burden of PT should match with the requirement of client.

x. The making contact arms (upper & lower) of the circuit breaker shall be encased in polyprolene tubes. Penetration type bushings shall be provided in the busbars & cable compartment for the fixed contacts.

xi. Safety shutters shall be provided to cover up the fixed high voltage contacts on busbar and cable sides when the carriage is moved to Isolated/Disconnected position. The shutters shall move automatically with the movement of the draw out carriage. It shall, however, be possible to open the shutters of busbars side and cable side individually.

xii. Mechanically operated circuit breaker auxiliary switches of minimum 6 NO + 6 NC ways, shall be provided for control and indication purposes. Control wiring shall be done by 1.5 sq. mm, 1.1 kV grade stranded copper PVC insulated wires. All control device shall be MCB type.

xiii. Terminal blocks shall be clamp type suitable for connection of only 2 wires per terminal and shall be 650 V grade. The LT control circuit shall be routine tested to withstand 1.5 kV for one minute.

xiv. Busbar compartment shall be provided at the rear. Electrolytic copper busbars shall be of rectangular cross section and insulated. Busbars shall be supported properly by cast epoxy resin insulators so as to withstand thermal and dynamic
stresses during system short circuits. Busbars shall be provided with necessary color coding for phases indication. The busbars shall be designed to withstand a temperature rise of 60 deg. C above and ambient temperature of 45 deg. C.

xv. **BUSBAR AND REGULATORS**

All bus bars and jumper connections shall be of electrolytic copper conforming to relevant IS Standards. They shall be adequately supported on epoxy insulators to withstand electrical and mechanical stresses due to specified short circuit currents. Busbar cross section shall be uniform throughout the length of switch board.

Contact surface at all joints shall be properly cleaned and No-oxide grease applied to ensure an efficient and trouble free connections. All bolted joints shall have necessary washers for maintaining adequate contact pressure. All connection hardware shall have high corrosion resistance.

Bus bar insulators shall be of track-resistance, high strength, and non-hygroscopic, non-combustible type & shall be suitable to withstand stresses due to over voltages and short circuit current. Busbar shall be supported on the insulator such that the conductor expansion and contraction are allowed without straining the insulators. The temperatures of the busbars and all other equipments, when carrying the rated of relevant Indian Standards, duly considering the specified ambient temperature.

xvi. **EARTHING AND PROTECTIVE EARTHING**

Copper earthing bus shall be provided. It shall be bolted/ welded to the framework of each panel. The earth bus shall have sufficient cross time fault currents to earth without exceeding the allowable temperature rise. Suitable arrangement shall be provided at each end of the earth for bolting. Earthing conductors and earth bus shall run inside at the back of the panel for entire length. Facilities shall be provided for integral earthing of busbars & feeder circuit. Earthing rod consisting of 16 Sq.mm. stranded/flexible copper cable 15 Mtr. long and connectors shall be supplied. Cost of this earthing rod is deemed to be included in the cost of VCB Panel.

xvii. **METERING AND PROTECTION**

The VCB Panel Board shall be provided with epoxy resin current transformers for metering and protection. The protection CT’s shall be of accuracy class 5P 10 of 2705- Part –III- 1992. The metering CTs shall confirm to the metering ratio and accuracy class 0.5 of is 2705-1992 for the incomer and Class I for the outgoing panels. Ammeter and voltmeter to be installed on panel shall be digital type. Voltmeter transformer of burden not less than 100 VA shall be 0.5 as per IS 3156 Part-I to Part-III for incomer and class I for outgoing panels. The PT shall be fixed/withdraw able type. HRC fuses/ MCB shall be provided on both HV and LV side. All meters shall be 96mm squire pattern, flush mounting type necessary selector switches. Necessary lamps of low voltage type with built in resistors shall be provided (maximum wattage 2.5watt. Burden of CT should match with the
xviii. Metering and Protection to be provided in Panels shall be as detailed below:

### INCOMING PANELS - 630 A 11 kV VCB BREAKER PANEL

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Set -11KV/110Volts, 3 phase PT Class -1.0 accuracy and 100 VA burden with 1 No. Voltmeter (0-15KV), digital type with built-in selector switch and protection MCBs for HT metering up to 12 KV on Incomer (IS-3156)</td>
<td></td>
</tr>
<tr>
<td>1 Set- Ammeter Digital Type with built-in selector switch.</td>
<td></td>
</tr>
<tr>
<td>1 Set-Microprocessor based relay with O/L, S/C and E/F protection. Relay shall be communicable on modbus protocol of IBMS.</td>
<td></td>
</tr>
<tr>
<td>1 Set of dual core dual ratio 3 CTs of suitable ratio 15VA burden and accuracy Class-0.5 for metering and class 5P10 for protection. (IS-2705-1992)</td>
<td></td>
</tr>
<tr>
<td>1 Set calibrated intelligent multi function digital panel meter of class 0.5 accuracy with communication interface port RS 485 for giving output on MOD BUS protocol of IBMS for receiving V, A, KVA, KVAh, KW, KWH, Hz, KVAR, PF, MDI individual total harmonic distortion with suitable rating CTs etc complete with wiring connections etc.</td>
<td></td>
</tr>
<tr>
<td>1 Set R/Y/B phase LED indication lamp</td>
<td></td>
</tr>
<tr>
<td>1 Set Red - ON, Green - OFF, TRIP, TRIP CIRCUIT HEALTHY, SPRING CHARGE, DC ON. (6 Nos. Ind. Lamps (LED TYPE) for each set).</td>
<td></td>
</tr>
<tr>
<td>1 Set of Push button for Emergency Tripping with 1 NO + 1 NC contacts &amp; inscription plates.</td>
<td></td>
</tr>
<tr>
<td>1 Set Trip / Neutral / Close Breaker Control Switch.</td>
<td></td>
</tr>
<tr>
<td>1 Lot - Master Trip Relays / Lockout Relays / Anti pumping / Aux. Relays/ Over current/ Earth Fault/ Phase Sequence Relay for Incoming VCB Feeders as required.</td>
<td></td>
</tr>
</tbody>
</table>

### OUTGOING PANELS - 630 A, 11 KV VCB BREAKER PANEL

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 set Ammeter digital type with built-in selector switch.</td>
<td></td>
</tr>
<tr>
<td>1 set -Microprocessor based relay with O/L, S/C and E/F protection. Relay shall be communicable on modbus for protocol of IBMS.</td>
<td></td>
</tr>
<tr>
<td>1 Set of dual core 3 CTs of 15VA burden and accuracy Class-1.0 for metering and class 5P10 for protection.</td>
<td></td>
</tr>
<tr>
<td>1 set R/Y/B phase LED indication lamp</td>
<td></td>
</tr>
</tbody>
</table>
1 set Red - ON, Green - OFF, TRIP, TRIP CIRCUIT HEALTHY, SPRING CHARGE, DC ON and AC ON. Indication LED lamps (7 Nos. Ind. Lamps for each set)

1 set of Push button for Emergency Tripping with 1 NO + 1 NC contacts & inscription plates.

1 set Trip / Neutral / Close Breaker control switch.

1 set calibrated intelligent multi function digital panel meter of class- 1.0 accuracy with communication interface port RS 485 for giving output on BACNET / MOD BUS protocol of IBMS for receiving V, A, KVA, KVAh, KW, KWH,F, KVAR & PF etc. complete with wiring.

1 Set 8 window solid state audio/ Visual Annunciators with Test/ Accept/ Reset push buttons and Electronic Hooter.

1 Lot - Master Trip Relays / Lockout Relays / Anti pumping / Aux. Relays/ Over current/ Earth Fault for Outgoing VCB feeder as required.

The Incoming & Outgoing VCBs panels shall SCADA/BMS compatible.

xix. OPERATING MECHANISM

Vacuum Circuit Breaker shall be equipped with motorized spring charge. These operating mechanisms shall be of the stored energy type. In the closed state of the breaker, the energy stored in the springs shall be suitable for O-C-O duty.

Interlocking and Safety Arrangement

a. Vacuum Circuit Breaker shall be provided with the following safety and interlocking arrangements:

b. The draw out carriage cannot be moved from either test/disconnected to service position or vice versa, when the circuit breaker is ‘On’.

c. The circuit breaker cannot be switched ‘ON’ when the carriage is in any position between test & service position.

d. The front door of the panel cannot be opened when the breaker is in service position or in an intermediated position.

e. The low voltage plug & socket cannot be disconnected in any position except test/isolated position.

f. The door cannot be closed unless the LV plug has been fitted.

g. It shall be possible to mechanically close and trip the circuit breaker through push buttons with the circuit breaker in service position and the door closed.

h. Individual explosion vents shall be provided for breaker, busbar, cable
chambers on the top of the panel to let out the gases under pressure generated during an unlikely event of a fault inside the panel.

i. Circuit Breaker & sheet metal enclosure shall be fully earthed.

j. Self locking shutters shall be provided which close automatically and shall be interlocked with the movement of the draw out carriage mechanism.

xx. **Rating:**

The rating of the vacuum circuit breaker shall be as below

- Rated Current 630A for I/C and 630 A for O/G Panels
- Rated Voltage 11 KV
- Rated Frequency 50 Hz
- Rated making capacity As per relevant standards.

xxi. **Accessories:**

- a. Circuit Breakers shall be provided with the following accessories.
- b. Auxiliary Switch with minimum 5 NO + 5 NC auxiliary contacts.
- c. Tripping Coil
- d. Mechanical Operation Counter
- e. Spring Charging Handle

xxii. **Mounting**

Vacuum Circuit Breakers shall be mounted as per manufacturer’s standard practice.

xxiii. **Auxiliary Supply**

- a. The tripping shall be at 24 Volt D.C. through a power pack unit or Battery Charger
- b. Space heater indication & other auxiliary supply requirement shall be at 230 V AC. Necessary termination arrangements complete with isolating switch, control fuse & link shall be provided at one place in the panel for receiving the purchaser's cable.

xxiv. **TESTS**

xxv. **Factory Tests**

The circuit breakers panel shall be subjected to routine tests at manufacturer’s
works in accordance with the details specified in the relevant IS specifications. These shall however necessarily comprise of the following.

a. Power frequency voltage test on the main power circuit.

b. Verification of the correct wiring/Functional Test.

c. Dielectric test at 1.5kV on the control circuit. Apart from above, the vendor shall submit the routine test certificates for the following equipment.

   - Circuit Breakers
   - Current Transformers
   - Voltage Transformers

d. Temperature rise test.

e. Impulse & power frequency voltage test

f. Short time current test on circuit breaker.

xxvi. **Site Test**

xxvii. **General**

   a. Verification for completion of equipment, physical damage/deformities.

   b. Alignment of panel, interconnection of busbars & tightness of bolts & connection etc.

   c. Interconnection of panel earth busbar with plant earthing grid.

   d. Inter panel wiring between transport sections.

   e. Cleanliness of insulators and general Cleanliness of panel to remove traces of dust, water etc.

xxviii. **Circuit Breaker & Panel**

   a. Check for free movement of circuit breaker, lubrication of moving part & other parts as per manufacturers manual.

   b. Manual/Electrical operations of the breaker and Functional test as per drawings.

   c. Meggar before the Hi Pot test.

   d. H.T. Test - Hi Pot test (Power frequency withstand test for one minute at 28kV RMS). At site Hi Pot test is carried out at 80% of 28kV RMS value.
e. Meggar after the Hi Pot test.

f. CT/PT ratio/polarity primary injection test.

g. Secondary injection test on relays to practical characteristics.

1.2. 11 KV HT CABLES

11 kV cable from HT Panel to Transformers in each Substations.

The size & runs of the HT cables shall be decided as per the Electrical Load requirements and rated short circuit capacity of Substations & HT cable Schedule shall be got approved from Engineer-In-Charge.

i. Construction

All HT cables shall be of 11 kV grade, armored, aluminum conductor, XLPE insulated, earthed & PVC sheathed cables shall be manufactured & tested in accordance with relevant IS Code Specifications.

ii. 11KV CABLE JOINTS/ TERMINATIONS

Terminal joints shall be carried out as per IS specifications. Heat shrink cable termination kit shall be used for terminations & straight through joints.

iii. INSTALLATION OF CABLES

Cable laying in ground, Cable trays, Ducts or fixing on Wall shall be carried out as per CPWD specifications for Electrical works Part II as amended up to date. Cable route marker shall be provided at regular intervals as per CPWD specifications. Cost of cable route markers is deemed to be included in the quoted cost of cables/cable laying.

iv. H.T. CABLE (XLPE) (33 KV & 11 KV)

The cross-linked polyethylene (XLPE) cable shall be aluminium conductor PVC outer sheath steel strip armoured over inner sheath construction. XLPE cable shall conform to testing in accordance with IS: 7098 (Part-I) 1977 and (Part-II) 1973. The screening shall be done on individual cover. The armouring applied over the common covering shall be flat steel wires. Each and every length of cable shall be subjected to routine test.

Terminal joints shall be carried out as per IS specifications. Heat shrink cable termination kit shall be used for terminations & straight through joints.

While laying underground cables in ducts care should be taken so that any underground structures such as water pipes, sewerage lines etc. are not damaged. Any telephone or other cable coming in the way shall be properly protected as per instructions of the Engineer-in-charge. The H.T. cable shall be laid at least 900mm for cable upto 33 KV (E) below the ground level in a trench 450mm wide.
Insulation tests shall be done before and after laying of cables.

After laying and jointing work is completed a high POT test shall be performed in presence of Engineer and test results submitted for approval in order to ensure that they have not been damaged during or after the laying operation. In case, the test results are unsatisfactory, the cost of all repairs and replacement and all extra work of removal and relaying will be made good by the contractor without any extra cost.

SECTION 2: DISTRIBUTION TRANSFORMER

2.1 11/0.433 KV DRY TYPE TRANSFORMER (ON LOAD TAP CHANGER TYPE)

xxix. GENERAL

Power transformers shall be Cast Resin Dry Type for indoor use. The transformers shall be suitable for 11KV/433 Volts, 50 Hz and 3-phase. All the transformers shall be ON LOAD TAP CHANGER type with RTCC Panels.

The design manufacture and performance of transformer shall comply with all performance of equipment status, regulations and safety codes in the location where the transformers will be installed. Transformers shall conform to the latest applicable standards. Transformer losses at 50% & 100% loads & impedance shall be as per ECBC Building norms conforming to Table 7.1 of ECBC-2017. Transformers’ incoming feeders in the LT Panel would be equipped with metering class current transformers (CT’s) & potential transformers (PT’s) so that periodic loss monitoring can be carried out.

xxx. CODES AND STANDARD

Transformers shall comply with the latest edition of Indian Standards No. IS-1180 - Part I to Part V (Oil Filled Transformer) and IS-11171 for Dry Type Transformer. Latest Stadards as applicable shall be followed the Insulating materials, Bushing, Installation and Maintenance of the Transformer.

xxxi. SERVICE CONDITION

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altitude</td>
<td>Less than 1000 meters.</td>
</tr>
<tr>
<td>Maximum Ambient Temp</td>
<td>50 deg. C</td>
</tr>
<tr>
<td>Minimum Ambient Temp</td>
<td>0 deg C</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>100 %</td>
</tr>
<tr>
<td>Installation</td>
<td>Corrosive, dusty, humid and tropical.</td>
</tr>
</tbody>
</table>
xxxii. **RATING AND TYPE**

The Transformer shall have core type construction, 3 phase and shall be suitable for Indoor service under the climatic conditions prevailing at site. The Transformer shall be capable of withstanding thermal and mechanical effects of short circuit at terminals of any winding with full voltage maintained on other winding as per IS: 2026.

xxxiii. **WINDING**

The primary and secondary winding shall be of electrolyte copper conductors. The high and low voltage winding shall be totally encapsulated and should be cast under vacuum in moulds with fiber glass reinforce epoxy resin laminate. Both HV and LV winding of each phase shall be separately cast as arigid tubular coil with no mechanical and electrical connection between their co-axial arrangements. The Transformer shall be free of partial discharges at least up to 1.1 times the rated voltage.

The winding shall absorb no. moisture under the worst tropical conditions collection of moisture and dust over the winding shall not any way affect the insulation strength of the winding.

xxxiv. **CORE**

The transformer core shall be build up with high non-aging low and high permeability CRGO Silicon steel lamination. CRGO sheet shall be coated with inorganic material or equivalent insulation to reduce eddy current to minimum. After shearing, the laminations shall be treated to remove all burrs and shall be annealed to remove all the residual stresses.

Core frame work and clamps shall be arranged and tighted to securely hold lamination in order to prevent any settling or displacement in case of heavy shocks during transport, handling or short circuits. All the Iron parts except the core shall be galvanized and treated with high temperature resistance paint. Core Fastening shall be insulated to reduce losses and avoid spots. Transformer shall be designed to withstand 10 % over fluxing corresponding to rated voltage.

Suitable lugs shall be provided for lifting the complete core and coil assembly of the transformer.

xxxv. **INSULATION**

Interturn and inter coil insulation shall be designed such that di - electric stress is uniformly distributed throughout the winding under all operating conditions. The winding shall be provided with Class 'F' Insulation.
xxxvi. TEMPERATURE RISE

The Temperature rise of the winding shall not exceed 90deg by resistance on continuous full load above maximum ambient temperature of 50 Deg C and in no case shall reach value that may damage the core itself or other adjacent part.

xxxvii. TAP CHANGING:

"ON LOAD" circuit tap changing with AVR arrangement on H.V side is to be provided. The tapping is to be provided for variation on high voltage side from + 5% to - 15% steps of 1.25% each. Automatically operated STEPLESS "ON LOAD Tap Changing Switch" having a position indicating lights & Locking device and complete with Automatic Voltage regulator and its Control panel shall be provided separately.

xxxviii. VECTOR GROUP:

Transformer shall have the vector group of Dyn 11.

xxxix. IMPEDANCE

The desired impedance shall be as mentioned in the IS:11171 and ECBC norms.

xl. FLUX DENSITY

The maximum flux density at any point in the winding shall not exceed 1.6 Tesla on the normal rated tap voltage and frequency.

xli. CURRENT DENSITY

The Maximum current density at any point in the winding shall not exceed 2.2 Amp. Per sq.mm at the rated full load, voltage and frequency.

xlii. COOLING

The Transformer shall be designed for natural cooling (AN) or forced cooling as required for smooth functioning.

xliii. ENCLOSURE

Transformer shall be provided with a sheet steel enclosure with adequate provision for ventilation. The degree of protection of enclosure shall be IP 21 for indoor installation and IP 33 for outdoor installations. The sheet steel thickness of enclosure shall be minimum 2mm.

xliv. CABLE TERMINATION
The low voltage side of the transformer shall be suitable to receive Sandwich Aluminium Bus Duct of suitable capacities from the top of the Transformer. A suitable size of flange to be provided for connecting the suitable size overhead sandwich busducts in the LT Box.

H.T. sides of the transformers shall have cable end boxes to receive 3 C X 300 sq.mm size of 11KV HT cables.

All cable end boxes shall have bore holes to match the opening for each cable specified and shown in the single line diagram.

xlv. **EARTHING**

Two main earthing terminals shall be connected to the terminals provided for transformer.

xlvi. **FITTINGS AND ACCESSORIES**

Rating and Terminal Marking Plate of the Transformer including the details of OFF circuit changing voltage of the links.

Earthing terminal with Lugs.

Transformer Neutral Earthing terminal.

Marshal Box with wiring and terminal and temperature scanner.

PT 100 type temperature scanner and its connection with marshal box.

Neutral CT 2000/1 Amp. And its connection with marshal box for 2000 KVA Transformer only.

Limit switch in all hinged door fix door and wiring till marshal box.

HV cable end box at primary.

LT bus Trunking box at secondary.

4 Nos. Plan bi-directional rollers.

Inspection windows shall be provided in the cover.

Lifting lugs for both the transformer and core shall be provided.

xlvii. **RTCC PANEL**
RTCC Panel shall be provided to operate OLTC from control room located in substation. RTCC shall be provided with main switch, a sequence selector switch. RTCC shall be provided with lower push button & raise push button, tap change in progress & complete. A.C supply ON/OFF lamp indicator & AVR relay operated operation indication. Cubical panel shall be totally enclose, floor mounting and fabricated with a framed structure with rolled/folded sheet steel channel section of minimum 2mm thickness.

All the sheet steel work forming the exterior of RTCC panel shall be smoothly finished and all steel work used in construction of RTCC panel shall undergone a rigorous metal treatment process consisting of effective cleaning by hot alkaline degreasing solution followed by the cold water rinsing, pickling in dilute sulphuric acid to remove scales and rust formation, a recognized phosphating process, passivating in deoxidize to retain & augment the effects of phosphating, drying with compressed air and dust free atmosphere, primer coating with two coats of highly corrosion resistant primer applied under strictly controlled conditions and finished coat of stoving. RTCC Panels shall be connected with respective transformers through suitable size multicore copper conductor armoured control cables.

The following components shall be provided in the RTCC panel:

- Digital Tap Position Indicating Meter
- Raise/Lower Push Buttons for Remote Control of OLTC
- Tap Change in Progress Signal Lamp.
- Supply on Signal Lamp
- Local / Remote Control Indicating Lamps & Selector switch
- Panel illuminating lamp with door switch.
- Space Heater with Switch and Thermostat.
- Automatic Voltage Relay with Time Delay Element.
- Selectors switch for Auto/Manual Operation.
- Undrilled Gland Plate for Cable entry.
- Earthing Terminal
- Lifting Eyes Bolts.
xlviii. INSTALLATION OF TRANSFORMER

Installation of transformer shall be carried out in accordance with manufacturer's instructions and/or as directed by purchaser.

All power/control connections and mechanical joints shall be completed, checked and adjusted to ensure safety and satisfactory operation of the transformer.

Transformer shall not be placed on bare ground during unloading but it shall be placed on wooden sleepers. After placing on foundation, alignment, leveling etc. shall be carried out in best workman like manner.

For the power/control cabled projecting above the ground, the termination to cable box shall be run in GI conduits of suitable cross section and the same shall be supported properly and pipe ends shall be sealed with bitumen compound.

The cable box of detachable type of the transformer shall be supported properly so as to facilitate taking out of the transformer for repair without disturbing the cables.

xlix. TEST CERTIFICATES

Test certificate shall be furnished in required number of copies for approval.

The routine, special and type test certificate of the transformer shall be furnished.

The routine and type test certificates of miscellaneous components shall be furnished or approval.

l. ROUTINE TESTS

During manufacture and on completion the transformer shall be subjected but not limited to the following Routine Tests as laid down in the latest revision of the IS 11171 IEC - 726

i) Applied voltage test

ii) Induced voltage test

iii) No-load loss and excitation current tests

iv) Impedance voltage and load loss tests

v) Resistance measurement

vi) Ratio tests
vii) Polarity and phase relation tests

viii) Insulation resistance tests

ix) Insulation power factor tests

li. **TYPE TESTS**

The type test certificates for the following type tests carried out on similar capacity rating shall be submitted along with the routine test certificates.

i) Heat run test

ii) Impulse test

lii. **FIELD TEST**

After installation a site, the transformer shall be subjected to the following field test:

i) Construction inspection

ii) Ratio tests

iii) Polarity test

iv) Tap change operation test.

liii. **ELECTRICAL & PERFORMANCE REQUIREMENT:**

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

b) Transformer shall be designed for 110% continuous over fluxing withstand capability.

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

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

e) Temperature Rise for continuous full load application shall be guided by Maximum temperature rise clause of IS 2026. The temperature rise shall not exceed 45 degree C by thermometer in oil or 50 degree C for winding over an ambient of 45 degree C.
Please note maximum ambient temperature shall be considered 50 degree C).

liv. **DRAWINGS AND O&M MANUALS:**

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

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

b) Crane requirements for assembly and dismantling of the transformer.

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

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

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

b) Drawings of Bus duct termination arrangement.

c) HV cable box arrangement & disconnecting chamber GA drawings.

d) Name plate and terminal making and connection diagram.

e) Assembly of OLTC gear mechanism & details of mechanism parts, limits, contours of wearing parts, timing gear adjustments etc.

**Technical Specification for Package Substation with VCB Breaker as protection on HT side**

- **CODE & STANDARDS:**

All equipment and material shall be designed manufactured and tested in accordance with the latest applicable IEC standards. The 12KV Package Substation Design must be as per IEC 62271-202.

The Package Sub-station offered shall in general comply with the latest issues including amendments of the following standards.

<table>
<thead>
<tr>
<th>Title</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Voltage Low Voltage Pre-Fabricated Substation</td>
<td>IEC:62271-202</td>
</tr>
</tbody>
</table>
### Design Criteria

Package Sub-station consisting of **11KV Non-Extensible VCB Ring Main Unit with breaker as protection + Transformer + Low Voltage Switchgear** with all connection accessories, fitting & auxiliary equipment in an Enclosure to supply Low-voltage energy from high-voltage system as detailed in this specification. The complete unit shall be installed on a substation plinth (base) as **Outdoor Substation** located at very congested places. The Vacuum Circuit Breaker shall be used to control and isolate the 11 kV/ 433 V Cast Resin Dry Type Distribution Transformer. The transformer Low Voltage side shall be connected to Low Voltage switchgear. The connection cables to consumer shall be taken out from the Low Voltage switchgear.

Package Substation shall be designed for Outdoor Type, Weatherproof installation.

The prefabricated-package substation shall be designed for a) Compactness, b) fast installation, c) maintenance free operation, d) safety for worker/operator & public.

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

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

### Service Conditions:

The Package substation shall be suitable for continuous operation under the basic service conditions indicated below

- **Ambient Temperature:** 40 Deg C
- **Relative Humidity:** upto 95%
- **Altitude of Installation:** upto 1000m

### Technical Specifications

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Voltage Switches</td>
<td>IEC 60265</td>
</tr>
<tr>
<td>Metal Enclosed High Voltage Switchgear</td>
<td>IEC 60298/</td>
</tr>
<tr>
<td></td>
<td>IEC62271-200</td>
</tr>
<tr>
<td>High Voltage Switchgear</td>
<td>IEC 60694</td>
</tr>
<tr>
<td>Low Voltage Switchgear and Control gear</td>
<td>IEC 60439</td>
</tr>
<tr>
<td>Power Transformers</td>
<td>IEC 60076</td>
</tr>
</tbody>
</table>
The Enclosure of High Voltage switchgear-control gear, Low Voltage switchgear-control gear & Transformer of the package substation shall be designed to be used under **normal outdoor service condition** as mentioned. The enclosure should take minimum space for the installation including the space required for approaching various doors & equipment inside.

- **Specific Requirement**

The main components of a prefabricated- package substation are Transformer, High-voltage switchgear-control gear, Low-voltage switchgear-control gear and corresponding interconnections (cable, flexible, bus bars) & auxiliary equipment. The components shall be enclosed, by either common enclosure or by an assembly of enclosure. All the components shall comply with their relevant IEC standards.

- **Ratings:**

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Voltage / Operating Voltage</td>
<td>kV rms</td>
<td>11</td>
</tr>
<tr>
<td>Rated frequency &amp; Number of phases</td>
<td>Hz &amp; nos.</td>
<td>50 &amp; 3</td>
</tr>
<tr>
<td>Rated maximum power of Transformer</td>
<td>kVA</td>
<td>630 KVA Cast Resin Dry Type Transformer, Off Load Tap Changer</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HV Insulation Level</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated withstand voltage at power frequency of 50 Hz</td>
<td>kV rms</td>
<td>28</td>
</tr>
<tr>
<td>Rated Impulse withstand Voltage</td>
<td>kV peak</td>
<td>75</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HV Network &amp; Busbar</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated current</td>
<td>Amp</td>
<td>630A</td>
</tr>
<tr>
<td>Rated short time withstand current</td>
<td>kA rms / 3 sec</td>
<td>21</td>
</tr>
<tr>
<td>Making capacity for switch-disconnector &amp; earthing switches</td>
<td>kA peak</td>
<td>52.5kA</td>
</tr>
<tr>
<td>------------------------------------------------------------</td>
<td>---------</td>
<td>--------</td>
</tr>
<tr>
<td>Breaking capacity of Isolators (rated full load)</td>
<td>A</td>
<td>630A</td>
</tr>
<tr>
<td><strong>LV Network</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>As per requirement to cater to all electrical loads. LT Panel &amp; Capacitor Banks shall be provided in LT Compartment for space economy.</td>
<td></td>
</tr>
</tbody>
</table>

**OUTDOOR ENCLOSURE**

- **Outdoor enclosure:**

The outdoor enclosure shall be made of galvanized Sheet Steel tropicalized to local weather conditions.

The CSS shall be made up of 1.5 mm thick non load bearing members and 2 mm thick load bearing members with a base frame made up of 4 mm HRCA.

The CSS shall have a 6 degrees slope to avoid water logging in case of rains or any other such issue.

The metal base shall ensure rigidity for easy transport & installation.

Substation will be used in outdoor application hence to prevent enclosure from rusting/corrosion, welding should be avoided.

The protection degree of the Enclosure shall be IP54 for LT & HT switchgear compartment & IP23 for Transformer compartment. Proper / adequate ventilation aperture shall be provided for natural ventilation by way of Louvers etc. Transformer compartment has to be designed in such away that, it meets IP class without any forced cooling arrangements.

Considering the outdoor application of the substation the doors shall be provided with proper interlocking arrangement for safety of operator and to avoid corrosion door should have stainless steel hinges.

Interconnection between HT switchgear and transformer shall be using 1C x 3R x 95 sq.mm Aluminum un armoured XLPE cable and between transformer and LT switchgear shall be using Aluminum busbar (as required)

**Internal Fault:** Failure within the package substation due either to a defect, an exceptional service condition or mal-operation may initiate an internal arc. Such an event may lead to the risk of injury, if persons are present. It is desirable that the highest...
practicable degree of protection to persons shall be provided. The Enclosure Design shall be tested for IAC AB as per IEC 62271-202. Type test report of arcing due to internal fault on similar designs should submit with offer.

**Covers & Doors:** Covers & doors are part of the enclosure. When they are closed, they shall provide the degree of protection specified for the enclosure. Ventilation openings shall be so arranged or shielded that same degree of protection as specified for enclosure is obtained. All covers, doors or roof shall be provided with locking facility or it shall not be possible to open or remove them before doors used for normal operation have been opened. The doors shall open outward at an angle of at least 90° & be equipped with a device able to maintain them in an open position.

**Earthing:** All metallic components shall be earthed to a common earthing point. It shall be terminated by an adequate terminal intended for connection to the earth system of the installation, by way of flexible jumpers/strips & Lug arrangement. The continuity of the earth system shall be ensured taking into account the thermal & mechanical stresses caused by the current it may have to carry. The components to be connected to the earth system shall include:

- **a)** The enclosure of Package substation,
- **b)** The enclosure of High voltage switchgear & control gear from the terminal provided for the purpose,
- **c)** The metal screen & the high voltage cable earth conductor,
- **d)** The transformer tank or metal frame of transformer,
- **e)** The frame &/or enclosure of low voltage switchgear,

There shall be an arrangement for internal lighting activated by associated switch for HV, Transformer & LV compartments separately.

**Labels:** Labels for warning, manufacturer’s operating instructions etc. shall be durable & clearly legible.

**Cleaning & Painting:** The enclosure shall be Powder coated with colour specific to Light and Dark Gray combination.

**Earthing**

Earthing arrangement shall be provided for earthing each cable, PVC cable gland, neutral busbar, chassis and frame work of the cubicle with separate earthing terminals at two ends. The main earthing terminals shall be suitably marked. The earthing terminals shall be of adequate size, protected against corrosion, and readily accessible. These shall be identified by means of sign marked in a legible manner on or adjacent to terminals.

Neutral bus bar strip shall be connected to Earthing terminal with help of GI strip of suitable capacity & nut-bolt arrangement.
TYPE / ROUTINE TEST ON PACKAGE SUBSTATION

TYPE TESTS FOR THE PACKAGE SUBSTATION:

The Package Substations offered must be type tested as per latest IEC 62271-202. The copy of type test summary should be submitted along with the tender. CSS manufactured at in JV consortium shall not be accepted.

Routine Tests: The routine tests shall be made on each complete prefabricated substation.

a) Voltage tests on auxiliary circuit.

b) Functional test.

c) Verification of complete wiring.

Test Witness: Routine test shall be performed in presence of Owner’s representative if so desired by the Owner. The Contractor shall give at least fifteen (15) days advance Notice of the date when the tests are to be carried out.

Test Certificates:

Certified reports of all the tests carried out at the works shall be furnished in three (3) copies for approval of the Owner.

Type Test Reports on similar design to Qualify Technical Bid:

Packaged Substation Enclosure:

- Tests to verify the degree of protection.
- Arcing due to internal fault 21KA/1 Sec. for IAC-AB as per latest IEC 62271-202 on similar design
- Short circuit test to prove the capability of the earthing circuits to be subjected to the rated peak and the rated short time withstand currents.
- Tests to verify the withstand of the enclosure of the prefabricated substation against mechanical stress.
- Type Test report supporting, Enclosure class of K20 for CSS Enclosure of similar design.

SECTION –3: LT PANELS

LT PANELS

1. GENERAL

The scope of supply covers design, fabrication, integrating, packing, dispatching to
site along with routine testing as per IEC of Low Voltage Switchgear & Controlgear Assemblies up-to 1000 V (will be termed as ‘LT Panel’ henceforth).

Main LT Panel, Distribution Boards & Sub Panels shall be factory fabricated by Original Equipment Manufacturer or their authorized system integrators/channel partners. All LT Panels, Distribution Boards & Sub Distribution Panels shall comply with IEC-61439 & manufactured accordingly. The Panels shall be indoor type, metal clad, floor mounted, free standing, totally enclosed, extensible type, air insulated, cubicle type for use on 415 Volts, 3-phase, 50 cycles system. All LT Panels shall be designed to accommodate suitable ratings of Incoming Feeders, Outgoing Feeders, Bus Couplers etc. to cater to electrical load requirements of various buildings & facilities. All LT Panels & Sub-Panels shall be BMS compatible and wired accordingly so that all relevant electrical parameters can be communicated to BMS system. All necessary wiring, cabling etc between LT Panels, Sub-Panels etc and BMS shall be carried out as per norms. All Incoming & Outgoing feeders of Main LT Panels located in Substations shall be controlled and monitored through BMS System. Incoming Feeders from Transformers & DG Sets shall also be controlled through Sync Relay/PLC for auto Load change over/load sharing.

Degree of protection shall be IP-42 for Indoor & IP-54 for Outdoor Panels. All Outdoor Panels shall be Double Door with suitable canopy. The short circuit current rating of LT switchgears shall be ≥ 50 kA.

All LT Panels shall have necessary instruments for Monitoring & Metering purpose to meet latest versions of ECBC & GRIHA criterion/requirements.

All incoming feeders of LT Panels shall be provided with R, Y, B, ON, OFF & Trip LED Type indication lamps. All outgoing feeders of LT Panels shall be provided with ON, OFF & Trip LED Type indication lamps.

2. SITE CONDITIONS:

The LT Panel will be located indoors and shall be designed to operate satisfactory at rated load under the service conditions. This equipment will be subject to the ambient temperature conditions at the site as specified in the Project Requirements.

a. Design Ambient Temperature - 45 Deg. C
b. Temperature rise - As per IEC 61439
c. Relative Humidity Max - 85%
d. Relative Humidity Min - 10%
e. Pollution - Up to Degree of pollution-3
f. Application - Indoor

3. CONSTRUCTION-STANDARDS
The equipments covered under this specification shall conform to the latest revisions of relevant Indian and International Standards some of which are listed below.

IEC 61439 part 1 & 2: Low voltage switchgear and control Gear assemblies

IS 13947 1993: General requirements of Switchgear and Control Gear for Voltage not exceeding 1000 / 1200V AC


IS 13703 1993: Low voltage fuses

IS 2705 1992: Current transformers

IS 694 1990: PVC insulated cables for voltages including 1100 V with Copper and Aluminum Conductor.

IS 1248 1983: Direct Acting Electrical Indicating Analog

IS 8623 1993: Low voltage Switch gear & control gear assemblies

IS 5082: Electrolytic Aluminum Busbar, Trunking system, Rod tubes sections for Electrical Purposes.

IS 13779 1999: AC Electric Meters / Static Meters.

a. MAIN/SUB PANELS SHALL BE: of metal enclosed, indoor, floor mounted, free standing construction (unless otherwise specified) type.

b. Made up of the requisite vertical sections, which when coupled together shall form continuous dead front switchboards. Provide dust and damp protection.

c. Be readily extensible on both sides by the addition of vertical sections after removal of the end covers in case of Main Panels.

d. All panels shall be front access type.

e. Main/Sub Panels shall be constructed only of materials capable of withstanding the mechanical, electrical and thermal stresses, as the effects of humidity, which are likely to be encountered in normal service.

Each vertical section shall comprise of the following:

a. A front-framed structure of rolled/ folded sheet steel channel section, of minimum 2 mm thickness, rigidly bolted together. This structure shall house the components contributing to the major weight of the equipment, such as circuit breaker cassettes, moulded case circuit breaker, main horizontal busbars, vertical risers and other front mounted accessories. The structure
shall be mounted on a rigid base frame of 100 mm height with folded sheet steel of minimum 2 mm thickness. The design shall ensure that the weight of the components is adequately supported without deformation or loss of alignment during transit or during operation.

b. A cable chamber housing the cable end connections, and power/control cable terminations. The design shall ensure generous availability of space for ease of installation and maintenance of cabling, and adequate safety for working in one vertical section without coming into accidental contact with live parts in an adjacent section.

c. A cover plate at the top of the vertical section, provided with a ventilating hood where necessary. Any aperture for ventilation shall be covered with a perforated sheet having less than 1 mm diameter perforations to prevent entry of vermin.

d. Front and rear doors fitted with dust excluding neoprene gaskets with fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors, generous overlap shall be assured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust.

e. The height of the panels should not be more than 2400 mm for LT Panels. Operating handle of breaker in top most compartments shall not be higher than 1800 mm. The total depth of the panel should be adequate to cater to proper cabling space and should not be less than 350 mm.

f. Doors and covers shall be of minimum 2 mm thick sheet steel. Sheet steel shrouds and partitions shall be of minimum 1.6 mm thickness. All sheet panels shall be smoothly finished, leveled and free from flaws. The corners should be rounded. The apparatus and circuits in the power control centers (panels) shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary degree of safety.

g. All doors shall be suitably earthed as per relevant IS standards.

Apparatus forming part of the Main/Sub Panels shall have the clearances more than as given below.

- Between phases - 32 mm
- Between phases and neutral - 26 mm
- Between phases and earth - 26 mm
- Between neutral and earth - 26 mm

When, for any reason, the above clearances are not available, suitable insulation shall be provided. Clearances shall be maintained during normal service conditions.

Creepage distances shall comply with those specified in relevant standards.
All insulating material used in the construction of the equipment shall be of non-
hygroscopic material, duly treated to withstand the effects of the high humidity,
high temperature tropical ambient service conditions.

Functional units such as circuit breakers and moulded case circuit breakers shall
be arranged in multi-tier formation, except that not more than two air circuit
breakers shall be housed in a single vertical section. Cable entry for various
feeders shall be from the rear. Panel shall be suitable for termination of bus duct
for incoming breakers.

Metallic/insulated barriers shall be provided within vertical sections and between
adjacent sections to ensure prevention of accidental contact with:

a. Main busbars and vertical risers during operation, inspection or
   maintenance of functional units and front mounted accessories.

b. Cable termination of one functional unit, when working on those of adjacent
   unit/units.

All doors/covers providing access to live power equipment/ circuits shall be
provided with tool operated fasteners to prevent unauthorized access.

Provision shall also be made for permanently earthing the frames and other metal
parts of the switchgear by two independent connections.

4. METAL TREATMENT & FINISH

All steel work used in the construction of the Main/Sub Panels should have
undergone a rigorous metal treatment process as follows:-

a. Effective cleaning by hot alkaline degreasing solution followed by cold water
   rinsing to remove traces of alkaline solution.

b. Pickling in dilute sulphuric acid to remove oxide scales & rust formation, if
   any, followed by cold water rinsing to remove traces of acidic solution.

c. A recognized phosphating process to facilitate durable coating of the paint on
   the metal surfaces and also to prevent the spread of rusting in the event of the
   paint film being mechanically damaged. This again, shall be followed by hot
   water rinsing to remove traces of phosphate solution.

d. Passivating in de-oxalite solution to retain and augment the effects of
   phosphating.

e. Drying with compressed air in a dust free atmosphere.

f. Panel shall be powder coated with epoxy based powder paint after the above
   process so as to render the material suitable for corrosive environment.

g. Paint shade shall be Pebble (light) grey, shade no RAL 7032 unless otherwise
   specified.
5. **BUSBARS**

The busbars shall be air insulated and made of high conductivity, high strength aluminum alloy complying with the requirement of IS-5082.

The busbars shall be suitable braced with non-hygroscopic SMC supports to provide a through fault withstand capacity of at least 50 kA RMS symmetrical for one second. The neutral as well as the earth bar should be capable of withstanding the above level. Ridges shall be provided on the SMC supports to prevent tracking between adjacent busbars. Large clearances and Creepage distances shall be provided on the busbar system to minimize possibilities of fault.

The Main/Sub Panels shall be designed that the cables are not directly terminated on the terminals of breaker etc. but on cable termination links. Cross-section area/size of aluminum busbars shall be designed considering current density as 0.8 Amp per sqmm. Likewise Cross-section area/size of copper busbars shall be designed considering current density as 1.2 Amp per sqmm. The main busbars shall have continuous current rating throughout the length of Panels. The cross section of neutral busbars shall be same as that of phase busbar for busbars of capacity up to 200Amp; for higher capacity the neutral busbar shall not be less than half (50%) the cross section of that the phase busbars. The busbar system shall consist of main horizontal busbar and auxiliary vertical busbars run in busbar alley/chamber on either side in which the circuit could be arranged/connected with front access.

Connections from the main busbars to functional circuit shall be arranged and supported to withstand without any damage or deformation the thermal and dynamic stresses due to short circuit currents. Busbars to be colour coded with PVC sleeves.

All MCCBs & ACBs shall be provide with spreader links/terminals or Bus Bar extension pieces for easy termination of cables.

Clamp or screw type control terminal blocks shall be provided for outgoing control cables.

Minimum 10% spare terminals shall be provided for future use. Control terminal block shall be separated from power terminal blocks by means of an insulating barrier.

6. **Protection Relays:**

Provision of Relays like Under Voltage & Reverse Power shall be incorporated in incoming Feeders in addition to the relays already inbuilt in the ACBs as mentioned above.

7. **CABLE TERMINATIONS**

Cable entries and terminals shall be provided in the Main/Sub Distribution Panels to suit the number, type and size of aluminium conductor power cables and copper
conductor control cable specified.

Provision shall be made for top or bottom entry of cables as required. A cable chamber 150 mm. high shall be provided at the bottom throughout the length and depth of the MDB/SDB. Generous size of cabling chambers shall be provided, with the position of cable gland and terminals such that cables can be easily and safely terminated.

Barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

8. **Auxiliary wiring and terminals:**

Wiring for all controls, protection, metering, signaling etc. inside the switchboard shall be done with 1100 V gray colour PVC insulated FRLS copper conductors. Minimum size of these conductors shall not be less than 1.5 mm\(^2\). However, CT circuit wiring shall be done with 2.5 mm\(^2\). Control wiring to components fixed on doors shall be flexible type.

10% spare terminals shall always be available in each terminal block. Control wiring up to these terminal blocks shall be done by supplier.

15% spare feeders of various ratings completely prewired shall be supplied in each MCC

All conductors should be terminated using compression type cable sockets / lugs at both the ends.

Each control wiring termination shall be identified at both the ends by PVC ferrules. The identification termination numbers should match with those on drawings. Suitable size SP MCB shall be used for tapping power for control circuit wiring.

For all motor starter feeders, provision for control wiring to remote ON/OFF control is to be made. The auxiliary wiring for the same shall be brought up to terminal block in the feeder's cubicle.

9. **LABELS**

Labels shall be anodised aluminium with white engraving on black background shall be provided for each incoming and outgoing feeder of Main/Sub Distribution and all Panels.

10. **TEST AT MANUFACTURES WORK**

All routine tests specified in IS: 8623-1977 shall be carried out and test certificates submitted.
11. INSTALLATION, TESTING AND COMMISSIONING

Installations of LT Panels shall be done as per CPWD norms/Specifications.

Commissioning checks and tests shall be included all wiring checks and checking up of connections. Primary/secondary injection tests for the relays adjustment/setting shall be done before commissioning in addition to routine Meggar test. Checks and tests shall include the following.

a) Operation checks and lubrication of all moving parts.

b) Interlocking function check.

c) Insulation test: As per CPWD Specifications for Electrical works Part I (2013)

d) Trip tests & protection gear test.

12. LT SWITCHGEARS

AIR CIRCUIT BREAKERS

13. GENERAL

Air Circuit Breakers shall be incorporated in Main Distribution Panels wherever specified. ACBs shall conform to IS 13947 (Part 2) & IEC 60947 (2) in all respects. ACBs shall be suitable for operation on 415 volts, 3-phase, 50Hz, AC supply.

All electrical panels shall be provided with meters & controls suitable for SCADA control & meeting requirements of ECBC.

14. TYPE AND CONSTRUCTION

Air Circuit Breakers shall be of enclosed pattern, dead front type with 'trip free' operating mechanism. It shall have microprocessor based electronic release. Air Circuit Breakers shall be EDO type (Electrically draw out type unless otherwise specified) with horizontal draw out carriage. The ACBs shall be strong and robust in construction with suitable arrangements for anchoring when in fully engaged or fully drawn-out positions. The carriage or cradle on which the breakers are mounted shall be robust design made of fabricated steel, supported on rollers. Cradle shall also comprise of main and secondary separable contacts and all draw out mechanism in a completely fig welded assembly. There shall be no dependence upon the switchboard frame for any critical alignment. The withdrawal arrangement shall be such as to allow smooth and easy movement.

All the current carrying parts of the circuit breakers shall be silver plated, suitable arcing contacts shall be provided to protect the main contacts. The contacts shall be of spring loaded design. The sequence of operation of the contacts shall be such that arcing contacts 'make before' and break after' the main contacts. Arcing contacts shall be provided with efficient arc chutes on each pole and these shall be
such suitable for being lifted out for inspection of main as well as arcing contacts. The contact tips and arc chutes shall be suitable for ready replacement. Self aligning isolating contacts shall be provided. The design of the breaker shall be such that all the components are easily accessible to inspection, maintenance and replacement. Inter phase barriers shall be provided to prevent flashover between phases.

15. OPERATING MECHANISM.

Air Circuit breaker shall be provided with a quick-make, trip free operating mechanism, the operating mechanism shall be 'strain-free' spring operated. The operating handle shall be in front of the panel type. The design shall be such that the circuit breaker compartment door need not be opened while moving the breaker from completely connected, through test, into the disconnected position. Electrical operated breakers shall have a motor wound spring charged closing mechanism. Breaker operation shall be independent of the motor, which shall be used solely for charging the closing spring. The operating mechanism shall be such that the breaker is at all times free to open immediately and the trip coil is energised. Mechanical operation indicator shall be provided to show open and closed position of breaker. Electrically operated breakers shall be additionally provided with mechanical indication to show charged and discharged condition of charging spring. 24 volt DC supply through battery backup for closing and opening for tripping circuit.

Means shall be provided for slow closing and opening of the breaker for maintenance purposes and for manual charging and closing of electrically operating breakers during emergencies.

16. INTERLOCKING AND SAFETY ARRANGEMENT

Air Circuit Breakers shall be provided the following safety and interlocking arrangements:

a. It shall not be possible for breaker to be withdrawn when in "ON" position.

b. It shall not be possible for the breaker to be switched on until it is either in fully inserted position or for testing purposes it is in fully isolated position.

c. The breaker shall be capable of being racked into 'testing', 'isolated' and maintenance' positions and kept locked in any of these positions.

d. 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.

e. The operating mechanism shall provide for racking the breaker into connected, test and disconnected positions without operating compartment door. When cubicle door shall be open position, the breaker can be pulled out to a fourth position, maintenance, where free access shall be possible to all parts of the breaker.
17. RATING

The rating of the circuit breaker shall be as per the drawings and schedule of quantities. Rated service breaking capacity ($I_{cs}$) of the breakers shall be 50kA unless otherwise specified at 415 volts. The rated making capacity shall be as per the relevant standard. Rated service Short Circuit Breaking capacity shall be equal to the Rated Ultimate Short circuit breaking capacity ($I_{cu}$) and short circuit withstand values ($I_{cw}$) for 1 sec.

18. RELAYS & ACCESSORIES

All ACBs (except bus couplers) shall be provided with micro-controller based release to offer accurate and versatile protections with complete flexibility and in the following zones:

- Overload (Phase & Neutral) protection with adjustable time delay.
- Short time protection with intentional delay.
- Instantaneous protection.
- Ground fault protection with intentional time delay.

The release should provide local LED indication for identification of type of fault, without requiring using external power supply. The release shall meet the EMI / EMC requirements.

Transformer & DG set Incomer ACB releases shall have LED/LCD display showing all Power & Energy Parameters ($I$, $I_{max}$, %loading, $I_{avg}$, $V$, $FREQ$, $PF$, $W$, $VAR$, $VA$, $Wh$, $VARh$, $Vah$, MD-Active, MD-Reactive, MD-Apparent, Temperature in each Phase).

The release shall draw its power from the main breaker CTs and shall require no external power supply for its operation, release shall also be connected to aux. supply for display of parameters during off or lightly loaded conditions.

The ACB should have breaker control through Modbus Breaker control.

The breaker shall be fitted with following accessories for control, signal and interlocking.

i) Auxiliary contacts 6 NO + 6 NC, of rating 16Amp at 415 volts 50Hz.

ii) Shunt release for tripping the breaker remotely and shall be suitable for 240 volt/415 volt 50Hz with range of operation from 10% to 130% of rated voltage.

iii) Micro switches shall be mounted on the cradle of draw out breaker to indicate the position of the breaker on the cradle.

   a. Kit for test/isolated indication.
b. Kit for service position indication.

c. Kit for shutter assembly.

iv) Accessories for following interlocking schemes shall be provided.

a. Accessory kit for locking the breaker in isolated position. This kit is useful for interlocking scheme as well as keeping personnel and equipment safe.

b. Door interlock kit: Panel or cubicle door cannot be opened with the ACB in Test or Service position.

c. Lockable trip push button.

19. MOUNTING

Circuit Breakers shall be mounted as per manufacturers’ standard practice.

20. TESTING

Testing of each circuit breaker shall be carried out at the works as per IS 2516 and the original test certificate shall be furnished in triplicate. The tests shall incorporate at least the following.

a. Impulse withstand test.

b. Power frequency withstand test.

c. Short circuit test.

d. Temperature - rise test under rated conditions.

MOULDED CASE CIRCUIT BREAKERS.

21. GENERAL

Moulded Case Circuit Breaker shall be incorporated in the Main/Sub Distribution Boards wherever specified. MCCBs shall conform to IS-13947 (Part 2) & IEC 60947 (2) in all respects. MCCBs shall be suitable either for single-phase AC 230 volts or three phase 415 volts. All MCCBs shall have microprocessor based over current and short circuit releases with adjustable current setting from 0.4 In to 1.0 In.

22. TECHNICAL SPECIFICATIONS

The MCCB should be current limiting type with trip time of less than 10 milli sec under short circuit conditions. The MCCB should be either 3 or 4 poles as per the requirement.
MCCB shall comply with the requirements of the relevant standards IS-13947 – Part 2 / IEC 60947-2 and should have test certificates for breaking capacities from independent test authorities CPRI / ERDA.

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

The breaking capacity of MCCB shall be minimum 35KA / 50 KA or as per the fault level. The rated service breaking capacity should be equal to rated ultimate breaking capacities (Ics=Icu).

The MCCBs shall be provided with following type of Relays for overload, short circuit & earth fault protection in the LT panels boards.

All incoming ACBs / MCCBs of LT Panel boards shall be with Microprocessor based release having inbuilt adjustable protections against Over Load (L), Short Circuit (S) and Ground Faults (G)] with time delay.

The outgoing MCCBs shall be with Thermal Magnetic type release for with adjustable Overload and fixed short circuit protections. MCCBs of ratings 250A & above shall be provided with Microprocessor based.

All MCCBs should be provided with the Rotary Operating Mechanism. The ROM should be with door interlock (with defeat feature) & padlock facility.

MCCB should have Spreader links & Phase barriers as standard feature. Superior quality of engineering grade plastics confirming to glow wire Tests as Per IEC 60695-2-1 should be used for insulation purpose.

The handle position shall give positive indication of 'ON', 'OFF' or 'Tripped' thus qualifying to disconnection as per the IS/IEC indicating the true position of all the contacts.

For Motor application, motor duty type MCCBs shall be selected with reference to Type 2 coordination chart provided by the manufacturer.

23. CONSTRUCTIONS

The MCCB's cover and case shall be made of high strength heat treatment 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 common operating handle for simultaneous operation and tripping of all the three phases. MCCBS shall be provided with rotary handle.

Suitable extinguishing device shall be provided for each contact. Tripping unit shall be of thermal magnetic or static release type provided in each pole &
connected by a common trip bar such that tripping of any pole operates all three poles to open simultaneously. MCCB shall be current limiting type.

Contact trips shall be made of suitable air resistant, silver alloy for long electrical life. Terminals shall be of liberal design with adequate clearance.

24. BREAKING CAPACITY

The breaking capacity of MCCB shall be minimum 35KA / 50 KA or as per the fault level. The rated service breaking capacity should be equal to rated ultimate breaking capacities (Ics=Icu).

25. TESTING

a. Original test certificate of the MCCB as per Indian Standards (IS) 315C-8370 shall be furnished.

b. Pre-commissioning tests on the Main Distribution/Sub Distribution Board incorporating the MCCB shall be done as per standard.

MEASURING INSTRUMENTS, METERING & PROTECTION

26. GENERAL

Direct reading electrical instruments shall be in conformity with IS-1248. The accuracy of direct reading shall be 1.0 for voltmeter and 1.5 for ammeters. Other type of instruments shall have accuracy of 1.5. The errors due to variations in temperature shall be limited to a minimum. The meter shall be suitable for continuous operation between-10 degree Centigrade to + 50 degree Centigrade. All meters shall be of flush mounting type of 96mm square or circular pattern. The meter shall be enclosed in a dust tight housing. The housing shall be of steel or phenolic mould. The design and manufacture of the meters shall ensure the prevention of fogging of instrument glass. Instruments 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 without removal of the seal. 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. The direction of deflection shall be from left to right.

Suitable selector switches shall be provided for all ammeters and voltmeters intended to be used on three-phase supply.

The specifications herein after laid down shall also cover all the meters, instrument 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.

27. DIGITAL AMMETERS
Ammeters shall be standard digital type. The ammeters shall be calibrated as per the latest edition of IS: 1248. Ammeters shall be instrument transformer operated, and shall be suitable for 5A secondary of instrument transformer. The scales shall be calibrated to indicate primary current, unless otherwise specified. The ammeters shall be capable of carrying sustained overloads during fault conditions without damage or loss of accuracy.

28. DIGITAL VOLTMETERS

Voltmeters shall be standard digital type. The voltmeter shall be calibrated as per the latest edition of IS: 1248. The range for 415 volts, 3 phase voltmeters shall be 0 to 500 Volts. Suitable 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.

29. CURRENT TRANSFORMERS

Current transformers shall be in conformity with IS: 4201 - 1983 as amended up to date in all respects. All current transformers used for medium voltage applications shall be rated for 1kV. Current transformers shall have rated primary current, rated burden and class of accuracy as required. However, the rated acceptable minimum class of various applications shall be as given below:

Measuring : Class 0.5 to 1

Protection : Class 5P10.

Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault of 50KA on medium voltage system. Terminals of the current transformers shall be marked permanently for easy identification of poles. Separate CT shall be provided for measuring instruments and protection relays. Each C.T. shall be provided with rating plate.

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 manner.

All Current Transformer shall be Cast Resin type.

30. MISCELLANEOUS

a. Control switches shall be of the heavy-duty rotary type with escutcheon plates clearly marked to show the operating position. They shall be semi-flush mounting with only the front plate and operating handle projecting.

b. Indicating lamps shall be of the filament type of low watt consumption, provided with series resistor where necessary, and with translucent lamp covers, bulbs & lenses shall be easily replaced from the front.
c. Push buttons shall be of the momentary contact, push to actuate type fitted with self-reset contacts & provided with integral escutcheon plates marked with its functions.

**LT CABLES**

**31. GENERAL**

LT Cables shall be supplied, inspected, laid tested and commissioned in accordance with drawings, specifications, relevant Indian Standards specifications as per given below. The cable shall be delivered at site in original drums with manufacturer’s name clearly written on the drums.

Total number of runs and size of LT power cables shall be designed so that the distribution losses do not exceed 3% of the total power usage in the system as per ECBC norms.

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>Reference</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IS 694 : 1990</td>
<td>PVC insulated cables for working voltages up to and including 1100 V</td>
</tr>
<tr>
<td></td>
<td>IEC 60227-1 to 5 : 1979</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>IS 694 : 2010</td>
<td>Polyvinyl chloride insulated sheathed and unsheathed cables with rigid and flexible conductor for rated voltages up to and including 450/750 V : Part general requirements (fourth revision)</td>
</tr>
<tr>
<td>3</td>
<td>IS: 7098: 1988 (Part-I)</td>
<td>XLPE insulated (heavy duty) electric cables. For working Voltages up to and including 1100 V (third revision)</td>
</tr>
<tr>
<td>4</td>
<td>IS 4288 : 1988</td>
<td>PVC insulated (heavy duty) electric cables with solid aluminium conductors for voltages up to and 1100 V (second revision)</td>
</tr>
</tbody>
</table>

**32. CABLE CONDUCTOR MATERIAL**

**a.** The LT Power cables shall be XLPE insulated, PVC sheathed, **copper conductor armoured** cable for sizes **up to & including 16 sqmm**, unless stated otherwise.

**b.** For LT Power cable sizes **above 16 sqmm**, cables shall be XLPE insulated, PVC sheathed, **Aluminium conductor armoured** cables, unless stated otherwise.
c. LT Control cables shall be XLPE insulated PVC sheathed type copper conductor armoured cables, unless otherwise stated.

All LT Power & Control cables shall conform to IS: 7098: 1988 (Part-I) with up to date amendments.

33. INSTALLATION OF CABLES

Cables shall be laid directly in ground, pipes, masonry ducts, on cable tray, surface of wall/ceiling etc. as indicated on drawings and/or as per the direction of Engineer In Charge. Cable laying shall be carried out strictly as per CPWD specifications.

34. INSPECTION

All cables shall be inspected at site and checked for any damage during transit.

35. JOINTS IN CABLES

The Contractor shall take care to see that the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilization and avoiding of cable joints. This apportioning shall be got approved from Engineer-in-Charge before the cables are cut to lengths.

36. LAYING CABLES IN GROUND

Cables shall be laid by skilled experienced workmen, using adequate rollers to minimize stretching of the cables. The cable drums shall be placed on jacks before unwinding the cable. With great care it shall be unrolled on over wooden rollers placed in trenches at intervals not exceeding 2 meter. Cables shall be laid at depth of 0.75 meters below final ground level for LT Cables and 1.20 meter below final ground level for HT cable. A cushion of sand total of 250 mm shall be provided both above and below the cable, joint boxes and other accessories. Cable shall not be laid in the same trench or alongside a water main.

The cable shall be laid in excavated trench over 80mm layer of sand cushion. The relative position of the cables, laid in the same trench shall be preserved. At all changes in direction in horizontal and vertical planes, the cables shall be bent smooth with a radius of bent not less than 12 times the diameter of cables. Minimum 3 meter long loop shall be provided at both ends of cable.

Distinguishing marks may be made on the cable ends for identifications of phases. Insulation, tapes of appropriate voltage and in red, yellow and blue colours shall be wrapped just below the sockets for phase identifications.

37. CABLE ROUTE MARKERS:

Cable route marker shall be provided at regular intervals as per CPWD specifications. Cost of cable route markers is deemed to be included in the quoted cost of cables/cable laying.
38. PROTECTION OF CABLES:

The cables shall be protected by bricks laid on the top layer of the sand for the full length of underground cable. Where more than one cable is laid in the same trench, the bricks shall cover all the cables and shall project a minimum of approximately 80mm on either side of the cables. Cable under road crossings and any other places subject to heavy traffic shall be protected by running them through Hume Pipes of suitable size. Hume Pipes for road crossing of the cables shall be laid at a depth of 1000 mm.

39. EXCAVATION & BACK FILL

All excavation and back fill required for the installation of the cables shall be carried out by the Contractor in accordance with the drawings and requirements laid down elsewhere. Trenches shall be dug true to line and grades. Back fill for trenches shall be filled in layer not exceeding 150mm. Each layer shall be properly rammed and consolidated before laying the next layer.

The Contractor shall restore all surfaces, road ways, side walks, curbs, wall or the works cut by excavation to their original condition to the satisfaction of the Engineer-in-Charge.

40. LAYING OF CABLES ON CABLE TRAY/SURFACE OF WALL/ CEILING

Cable shall be laid on perforated G.I. Cable tray/ladders. Cables shall be properly dressed before cable ties/clamps are fixed. Wherever cable tray is not proposed, cables shall be fixed on surface of wall or ceiling slab by suitable MS clamps/saddles. Care shall be taken to avoid crossing of cable.

41. CABLES ON HANGERS OR RACKS

The Contractor shall provide and install all iron hangers racks or racks with die cast cleats with all fixings, rag bolts or girder clamps or other specialist fixing as required. Where hangers or racks are to be fixed to wall sides, ceiling and other concrete structures, the Contractor shall be responsible for cutting away, fixing and grouting in rag bolts and making good.

The hangers or racks shall be designed to leave at least 25mm clearance between the cables and the face to which it is fixed. Multiple hangers shall have two or more fixing holes. All cables shall be saddled at not more than 150mm centres. These shall be designed to keep provision of some spare capacity for future development.

42. CABLES TAGS

Cable tags shall be made out of 2mm thick aluminium sheets, each tag 1-1/2 inch in dia with one hole of 2.5mm dia, 6mm below the periphery. Cable designations are to be punched with letter/number punches and the tags are to be tied inside the panels beyond the glancing as well as below the glands at cable entries. Tray
tags are to be tied at all bends. On straight lengths, tags shall be provided at every 5 metres.

43. **TESTING OF CABLES**

Prior to installation burying of cables, following tests shall be carried out. Insulation test between phases, phase & neutral, phase & earth for each length of cable.

   a) Before laying.
   b) After laying.
   c) After jointing.

Along with the test as prescribed in IS Code, cross sectional area shall also be checked. On completion of cable laying work, the following tests shall be conducted in the presence of the Engineer in Charge.

   a) Insulation Resistance Test (Sectional and overall).
   b) Continuity Resistance Test.
   c) Earth Test.

All tests shall be carried out in accordance with relevant Indian Standard code of practice and Indian Electricity Rules. The Contractor shall provide necessary instruments, equipments and labour for conducting the above tests & shall bear all expenses of conducting such test.

44. **TESTING & INSPECTION**

After completion of all work at the manufacturer's works the switchboards shall be inspected and tested in presence of Purchaser's representative. However, stage inspection may be carried out from time to time to check progress of work and workmanship. The following tests shall be carried out:

   a. All routine tests specified in relevant Indian/British Standards shall be carried out on all circuit breakers.
   b. Test for protective relay operation by primary or secondary injection method.
   c. Operation of all meters.
   d. Secondary wiring continuity test.
   e. Insulation test with 1000 Volts megger, before and after voltage test.
   f. HV test on secondary wiring and components on which such test is permissible (2 KV for one minute)
   g. Simulating external circuits for remote operation of breaker, remote indicating lights and other remote operations, if any.
   h. Measurement of power required for closing/trip coil of the breaker.
   i. Pick up and drop out voltages for shunt trip and closing coils.
   j. CT Polarity Test.

Vendor shall provide all facilities such as power supply, testing instruments and apparatus required for carrying out the tests. Required copies of test certificates for all the tests carried out alongwith copies of type test certificates and certificates from Sub-Vendor for the components procured from them are to be submitted before despatch of switchboards.
45. DRAWINGS AND INFORMATION

The Vendor shall furnish following drawings/documents in accordance with enclosed requirements:

a. General Arrangement drawing of the Switchboard, showing front view, plan, foundation plan, floor cutouts/trenches for external cables and elevations, transport sections and weights.

b. Sectional drawings of the circuit breaker panels, showing general constructional features, mounting details of various devices, bus bars, current transformers, cable boxes, terminal boxes for control cables etc.

c. Schematic and control wiring diagram for circuit breaker and protection including indicating devices, metering instruments, alarms, space heaters etc.

d. Terminal plans showing terminal numbers, ferrules markings, device terminal numbers, function etc.

e. Relay wiring diagrams.

f. Equipment List.

Vendor shall furnish required number of copies of above drawings for Purchaser's review, fabrication of switch boards shall start only after Purchaser's clearance for the same. After final review, required number of copies and reproducible shall be furnished as final certified drawings.

The information furnished shall include the following:

a. Technical literature giving complete information of the equipment.

b. Erection, Operation and Maintenance Manual complete with all relevant information, drawings and literature for auxiliary equipment and accessories, characteristics curves for relays etc.

c. A comprehensive spare parts catalogue.

46. TOOLS

One complete set of all special or non-standard tools required for installation, operation and maintenance of the switchboard shall be provided. The manufacturer shall provide a list of such tools with his quotation.

47. SPARES

The manufacturer/tenderer shall also supply a complete list of commissioning spares and tools. The same shall be included in the bid price. No extra payment shall be made on account of non-availability of spares during commissioning.
48. QUALITY ASSURANCE

Quality Assurance shall follow the requirements of DGHS/ HITES as applicable.

Quality Assurance involvement will commence at enquiry and follow through to completion and acceptance thus ensuring total conformity to Purchaser’s requirements.

49. DEVIATIONS

Deviation from specification must be stated in writing at the quotation stage. In absence of such a statement, it will be assumed that the requirements of the specifications are met without exception.

BATTERY & BATTERY CHARGER

50. SCOPE

The specifications give details of the Battery Charger suitable for HT/ LT Panels. The batteries are housed in the Bottom Compartment of the Battery Charger. Sealed maintenance Free Batteries upto 24V – 200AH or Lead Acid Batteries upto 24V – 150AH can be housed in the Battery Compartment. The Battery Charger is a composite Battery Charger cum DC Distribution Board.

51. GENERAL

The Battery Charger shall be Float cum Boost type, Thyristor controlled. The Charger shall have selector switch for Auto Float – Boost/Manual Float/Manual Boost Mode of operation. During Auto Float – Boost Mode, Automatic Changeover shall take place from Float Mode to Boost Mode and vice – versa. This means that when the Batteries are fully charged the charging shall automatically change from Boost charge to Trickle charge.

52. CONSTRUCTION FEATURE

Float cum Boost Charger and DC Distribution Board shall be housed in Sheet Steel Cubicle with Panels of 1.6mm thickness, louvers for ventilation, gland plate will be provided for cable entry from bottom. The cubicle shall be painted in Siemens Grey Shade. The Battery Charger shall be divided into two Compartments. The Upper Compartment shall house the Battery Charger & DCDB with all the necessary controls. The Lower Compartment shall be suitable for housing the Batteries.

53. PERFORMANCE

a. The D.C. Output Voltage of Float/Boost Charger shall be stabilized to within ± 2% for A.C. Input variation of 230V ± 10%, frequency variation of 50 Hz ± 5% and D.C. Load variation of 0 – 100%. The Voltage Regulation shall be achieved by a constant voltage regulator having fast response SCR controlled. The ripple content in output shall be within 3% of D.C. Output Nominal Voltage.
b. There shall be provision to select Auto Float/Manual Float /Manual Boost Modes. During Auto Float Mode the Battery Charging shall automatically changeover from Boost Mode to Float Mode and vice – versa. During Manual Float/Boost Modes it shall be possible to set the output volts by separate potentiometers.

c. The Battery Charger shall have automatic output Current Limiting feature.

54. COMPONENTS

The Battery Charger shall essentially comprise of the following:

a. 1 No. Double Pole ON/OFF MCB at A.C. Input.

b. 1 No. Pilot Lamp to indicate Charger ON.

c. 1 No. MAIN TRANSFORMER: Double Wound, naturally air – cooled, having Copper winding.

d. 1 Set Single Phase full wave Bridge Rectifier consisting of 2 nos. Diodes and 2 nos. SCR’s, liberally rated, mounted on Heat Sinks and complete with Resistor/Condenser network for surge suppression.

e. 1 No. Rotary Switch to select AUTO FLOAT/MANUAL FLOAT/MANUAL BOOST. During Auto Float Mode Automatic Changeover shall take place from Float Mode to Boost Mode and vice – versa.

f. 1 Set Solid State constant potential controller to stabilize the DC Output Voltage of the Float cum Boost Charger at ± 2% of the set value for AC Input Voltage variation of 230V ±10%, Frequency variation of ± 5% from 50Hz and simultaneous Load Variation of 0 - 100% and also complete with Current Limiting Circuit to drop the Float Charger Output Voltage upon overloads to enable the Battery to take over.

g. 1 No. Electronic Controller to automatically changeover Battery Charging from Boost to Float and vice – versa.

h. 1 No. DC Ammeter and Toggle Switch to read Charger Output Current and Battery Charge / discharge current.

i. 1 No. Moving Coil DC Voltmeter to read the DC Output Voltage.

j. 2 Set Potentiometer to adjust the output Voltage during Manual / Auto Float and Boost Modes.

k. 1 No. Double Pole ON/OFF MCB at Charger Output.

l. Dc Distribution Board :-

   INCOMER : 1 No. 63A DP MCB, as called for in BOQ.
OUTGOING : Suitable No. 16A/20A DP MCB, as called for in BOQ.

55. ALARM ANNUNCIATION

Visual and Audible Alarm with Manual Accept/Reset Facility shall be provided for the following:

I. A.C. Mains Fail.

II. Charger Fail.

a) Load/Output overvolt.

<table>
<thead>
<tr>
<th>RATING</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A C INPUT</td>
<td>230V ±10% AC 50 Hz Single Phase</td>
</tr>
<tr>
<td>D C OUTPUT</td>
<td>To Float/Boost charge 24V / 100AH</td>
</tr>
</tbody>
</table>

Batteries and also supply a continuous load

| CURRENT RATING: | 15.0 Amps |
| FLOAT MODE | 27.0 V Nominal (Adj. between 24.0 – 28.0V) |
| BOOST MODE | 28.0 V Nominal (Adj. between 24.0 – 30.0 V) |

Voltage Regulation: ± 2% of the set value

RIPPLE : Less than 3%.

For 24V / 100 AH Batteries the Charger Rating is given in the Specification for Batteries of other capacities refer to the Table as given below:

<table>
<thead>
<tr>
<th>BATTERY CAPACITY</th>
<th>CHARGING RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>24V / 40AH</td>
<td>10.0 Amp.</td>
</tr>
<tr>
<td>24V / 60AH</td>
<td>15.0 Amp.</td>
</tr>
<tr>
<td>24V / 100AH</td>
<td>15.0 Amp.</td>
</tr>
<tr>
<td>24V / 120AH</td>
<td>20.0 Amp.</td>
</tr>
<tr>
<td>24V / 150AH</td>
<td>25.0 Amp.</td>
</tr>
<tr>
<td>24V / 200AH</td>
<td>30.0 Amp.</td>
</tr>
</tbody>
</table>

EARTHING & LIGHTNING PROTECTION SYSTEM
Earthing system shall conform to CPWD General Specifications for Electrical Works (Part I-Internal), 2013. Earthing system shall comprise of suitable nos. of Earthpits with GI & Copper Plate electrodes, G.I. pipe as per IS-3043 & CPWD specifications.

Neutral Earthing with suitable size Copper strips and Copper plate earthpits for Transformer, DG Sets and other equipment as specified by OEMs shall be provided. The body earthing for transformers, HV & MV panels shall be done to a common earth bus connected to two separate and distinct earth electrodes.

For a single transformer Sub-station, the total number of earth electrodes shall be 4 (2 for neutral and 2 for connection to a common earth bus for body earthing). For a two transformer Sub-station total number of earth electrodes shall be 6 (4 for neutral earthing, two each for two transformers, and 2 for connection to a common earth bus for body earthing).

56. ELECTRODES

The earth electrodes shall be as per CPWD General Specifications for Electrical Works (Part I-Internal), 2013.

57. LOCATION OF EARTH ELECTRODES

Distance of earth electrode from any building and other earth electrode shall be as per CPWD specification & IS codes. Care shall be taken that the excavation of earth electrode may not affect the column footings or foundation of the building. In such cases electrodes may be farther away from the building. The location of the electrode earth will be a place where the soil has reasonable chance of remaining moist. As far as possible, entrances, pavements and road ways, are to be definitely avoided for locating the earth electrode.

58. WATERING ARRANGEMENT

Method of watering arrangement shall comply with CPWD general specifications.

59. SIZE OF EARTH LEAD

The recommended sizes of copper earth bus lead in case of Sub-stations shall be in accordance with General Specifications for Electrical Works (Part I-Internal), 2013 amended upto date. The minimum size of earth lead shall be 25 mm x 5 mm copper or equivalent GI strip.

60. INSTALLATION

All joints shall be riveted and sweated. Joints in the earth bar shall be bolted and the joints faces tinned. Where the diameter of the bolt for connecting earth bar to apparatus exceeds one quarter of the width of the earth bar, the connection to the bolt shall be made with a wider piece of flange of copper jointed to earth bar. These shall be tinned at the point of connection to equipment and special care taken to ensure a permanent low resistance contact to iron or steel. All steel bolts, nuts, washers etc. shall be cadmium plated, main earth bars shall be spaced suffi
ciently on the surface to which they are fixed such as walls or the side trenches to allow for ease of connections. Copper earthing shall not be fixed by ferrous fittings. The earthing shall suitably be protected from mechanical injury by galvanized pipe wherever it passes through wall and floor. The portion within ground shall be buried at least 60 cm deep. The earthing lead shall be securely bolted and soldered to plate or pipe as the case may be. In the case of plate earthing the lead shall be connected by means of a cable socket with two bolts and nuts. All washers shall be of the same materials as the plate or pipe. All iron bolts, nuts and washers shall be galvanized.

61. TESTING

After installation, the tests as specified in CPWD General Specifications for Electrical Work (Part I-Internal), 2013 shall be carried out and results recorded.

62. LIGHTENING PROTECTION SYSTEM

Lightening Protection System shall be provided for all buildings, blocks and facilities constructed under this contract as per IS/IEC - 62305:2010 amended up to date and NBC 2016.

Protection of buildings against lightning shall generally be done in accordance with latest IS-Code. The installation shall be done as per routes and location of equipment indicated on the drawing and bill of quantities. The conductors and the earth electrode conductor shall be fixed so that they are free to expand and contract. Special care shall be taken in the fixing of support to allow free movement.

The materials of lightning conductors, down conductors, earth termination etc. shall be reliably resistant to corrosion or be adequately protected against corrosion. All air terminations shall be GI and the conductors shall be GI.

The entire lightning protection system should be mechanically strong to withstand the mechanical forces produced in case of a lightning strike. The system shall be installed such that it does not spoil the architectural or aesthetic beauty of the buildings but on other hand at should meet IS code/safety code.

Horizontal air terminations should be so interconnected that no part of the roof is more than 9 metres away from the nearest horizontal conductor. For a flat roof horizontal air termination along the outer perimeter of the roof is used. For a roof of larger area a network of parallel horizontal conductors shall be installed. Horizontal air terminations shall be laid along contours such as ridges, parapets and edges of flat roofs and where necessary area flat surfaces in such a way as to connect each air termination to the rest and shall, they form a closed network.

All metallic finials, chimneys, ducts, vent pipes, railings, gutters, metallic flag staff, on or above the main surface of the roof of the structure shall be bonded to and form part of the air termination network. All air terminations shall be effectively recessed against over turning either by attachment to the object to be protected.
or by means to substantial braces and fixing which shall be permanently and rigidly attached to the buildings.

Down conductors shall be distributed around the outside walls of the structure. They shall preferably be run along the corners and other projection, due considerations being given to the locations of air terminations and earth terminations. Lift shafts shall not be used for fixing down conductors. Metal pipes leading rainwater from the roof to the ground may be connected to the down conductors but cannot replace them. Such conductors shall have disconnecting joints. All vertical conductors shall be plumbed before fixing. Insulation shall be provided between down conductors and wall.

The lightning protective system shall have as few joints in it as possible. Wherever joints in the down conductor above ground level are necessary they shall be mechanically and electrically effective. The joint overlap shall not be less than the width of the tape. In the down conductor below ground level there shall be no joint. The joints may be clamped, screwed, bolted, revitted, sweated, braced or welded. The bonding of the external metal forming part of a structural or drain water pipe shall have a cross sectional area not less than that employed for the main conductors. Gas pipe, however, in no case shall be bonded to the earth termination system.

Conductors shall be securely attached to the building to be protected by fasteners, which shall be substantial in construction, not subject to breakage and shall be of steel. The conductors shall be secured at not more than 900mm apart for horizontal run and 750mm for vertical run.

Where tape are required to pass through roof asphalting or other waterproofing membranes, a special seal shall be used comprising a 38mm diameter plastic, copper or aluminium tube with 100mm diameter flange 50mm from the top of the tube. The tube length shall suit the thickness of the roof through which the conductor passes, allowing for the tube to protrude 50mm above the membrane. The seal is to be asphalted in position and the conductor shall be sealed in the tube by a setting waterproof compartment.

Each down conductor shall have an independent earth termination. The interconnection of all the earth termination shall be preferable. It should be capable of isolation for testing purpose by “testing joints” at position approachable easily for the meggar testing. The whole of the system could have a combined resistance to earth not exceeding 2 ohm before any bonding has been affected to metal in or on structure or two surfaces below ground.

63. SAFETY REQUIREMENTS

Safety provisions shall be generally in conformity with appendices (A) and (C) of CPWD General Specifications of Electrical Works (Part I-Internal), 2013. In particular following items shall be provided:

(a) Insulation Mats
Insulation mats conforming to IS 15652: 2006 shall be provided in front of all HT & LT Panels as well as other control equipments as specified.

(b) First Aid Charts and First Aid Box

Charts (one in English, one in Hindi, one in Regional language), displaying methods of giving artificial respiration to a recipient of electrical shock shall be prominently provided at appropriate place. Standard first aid boxes containing required materials should be provided in each sub-station.

(c) Danger Plate

Danger Plates shall be provided on HV and MV equipments. MV danger notice plate shall be 200 mm x 150 mm made of mild steel at least 2 mm thick vitreous enameled white on both sides and with the descriptions in signal red colour on front side as required. Notice plates of other suitable materials such as stainless steel, brass or such other permanent nature material shall also be accepted with the description engraved in signal red colour.

(d) Fire Extinguishers

Portable CO₂ conforming to IS 2878: 1976/ chemical conforming to IS 2171: 1976 extinguishers, HCFC Blend A (P-IV) shall be installed in the sub-station at suitable places. Other extinguishers recommended for electric fires may also be used.

(e) Fire Buckets

Fire buckets conforming to IS-2546: 1974 shall be installed with the suitable stand for storage of water and sand.

(f) Tool Box

A Standard tool box containing necessary tools required for operation and maintenance shall be provided in the sub-station.

(g) Caution Board

Necessary number of caution boards such as “Man on Line” ‘Don’t Switch on’ etc. shall be available in the sub-station.

(h) Key Board

A keyboard of required size shall be provided at a proper place containing castle keys, and all other keys of sub-station and allied areas

CAPACITOR PANEL & HYBRID HARMONIC FILTER

64. SCOPE
Supply, installation, testing and commissioning of medium voltage capacitors and Automatic Power Factor Correction Panel (APFC) for improvement in power factor of electrical system. It will be connected to main LT panel. It shall improve power factor up to 0.97 (lagging) from initial power factor. For harmonic mitigation 7% detuned reactors shall be provided in capacitor panels. Capacitor panel shall be provided with day/night mode selector switch and double ratio C.Ts, for day/night mode. Day/night mode shall be selected based on estimated day/night load requirement.

65. **RATING**

The rating of Capacitor units shall be as per CPWD specifications for Electrical Works (Part - 4) Substations 2013.

66. **CAPACITOR BANK:**

Capacitor voltage shall be minimum 480 V when used with 7% reactors. Capacitors shall be MPP Heavy Duty type/ Gas filled type. The capacitor element used in unit shall have metallized polypropylene film (MPP) having low loss dielectric and impregnated with such impregnate, which shall have high dielectric constant, low viscosity and high chemical stability. The impregnate should be resin filled. The capacitor unit shall have over pressure dis-connector protection. Discharge resistance shall reduce the residual voltage to less than 50 volts within one minute.

General specifications:

- phase, delta connected, 50 Hz
- Overvoltage +10% (for 8h / 24h), + 15% (for 30m / 24h), + 20% (5m/24h), +30% (1m/24h)
- Overcurrent: 1.8 x In
- Peak Inrush current withstand: 250 x In
- Total watt-losses: < 0.45 W / kVAr
- 6000 switching operations per year
- IEC 60831

67. **DETUNED FILTER**

a. Detuned harmonic filter reactors shall be used along with power capacitors to mitigate harmonics amplification and to avoid electrical resonance in LV electrical networks.

b. The complete unit shall be impregnated under vacuum and over-pressure in impregnation resin. The insulation shall be Class H.
c. The reactors shall be made of high grade aluminum windings, having a three phase, iron core construction suitable for indoor use. The reactor shall be air cooled and the layout shall be in accordance with IEC 60289 / IS 5553.

d. The permitted tolerance of inductance is ± 3% of rated inductance value.

e. Reactor tuning factor shall be 7 % (189 Hz) and the current rating of the reactor shall include the effects of harmonics and other possible over-currents.

f. The limit of linearity of inductance of the filter reactor is: \(1.8*\text{In with } L=0.95*LN\).

g. The reactor shall be fitted with a temperature sensitive micro-switch in the center coil (normally open) for connection to trip circuits in case of high operating temperatures.

h. Power loss in each reactor shall be less than 5 W/kVar

i. Each reactor shall have routine test certificate for the above tests.

68. CONTACTOR:

- All contactors shall be AC duty, 3 pole air-break, magnetic, capacitor duty type. The rating of contactor shall be suitably assigned. The contactors shall be so chosen as to withstand inrush current due to parallel switching. Contactor should be with damping resistors to limit capacitor charging current.

- The individual capacitor bank/step shall be switched automatically / manually with selector switch as required using magnetic contactors suitable for switching capacitive currents. The contactor coil voltage shall be as specified.

- The minimum life expectancy of the contactor shall be one million switching operations.

- Contactor should be with surge suppressor.

- Operation voltage up to 690V

- Insulation voltage 1 kV

- Rated impulse withstand up to 8 kV

69. APFC CONTROLLER

The APFC controller should be microprocessor based and should correct power factor with the help of contactors by switching the required no. capacitor banks.

The controller should offer power factor correction without any need for manual intervention. The controllers should decide optimum configuration of capacitor.
banks in order to achieve desired power factor by taking into consideration the kVAR of each step, no of operations, total usage time, re-connection time of each step etc. Besides manual switching of capacitors should also be possible directly through the controller. The APFC controller should have the following basic features

- Backlit LCD display with multiple parameters displayed at the same time
- Auto step programmable
- Capable of measuring VTHD and ITHD values at least up to 15th order
- Automatic CT reversal sensing and correction
- Should be 1A / 5A CT selectable.
- Sensing shall be done at LT as well as HT side of the transformer
- Display of average weekly power factor
- Keypad lock feature to prevent operation by unauthorized persons
- Alarms for under/over compensation, high VTHD/ITHD, over temperature, capacitor failure, capacitor over-current, over/under voltage
- Individual capacitor's ON/OFF status and capacitor failure indication
- Temperature sensing feature with alarm in case of panel over heating
- Should have RS 485 communication protocol.

**SWITCHGEAR & PROTECTION:**

Suitable capacity duty contactor for each step shall be used and must be capable of capacitor switching duty. Busbars shall be suitably colour coded and must be mounted on appropriate insulator supports.

Power cable used shall have superior mechanical, electrical and thermal properties. Internal wiring between main bus bars, contactor, capacitor etc shall be made with 1100 volt grade PVC insulated FRLS copper conductor of appropriate size by using suitable copper crimping terminal ends etc suitable bus links for input supply cable termination shall be provided.

Control circuit shall be duly protected by using suitable rating MCB. An emergency stop push button shall be provided to trip the entire system (22.5 mm dia, mushroom type, press to stop and turn to reset). 440 Volt caution board shall be provided on the panel.

**TESTS AT MANUFACTURER'S WORKS:**

All routine and type tests as per IS:2834 relevant to capacitor banks as amended up to date shall be carried out at manufacturer's works and test certificates to be submitted.

**TEST AT SITE:**

Insulation resistance with 500 V DC Meggar shall be carried out and test results should be recorded.

Residual voltage shall be measured after switching of the capacitors and the same shall not be more than 50 Volts after one minute. Each discharge resister shall be tested for its working.

**INSTALLATION:**
Capacitor bank shall be installed at least 30 cm away from the walls on suitable frame work of welded construction. The earth terminals provided on the body of capacitor bank shall be bonded to main capacitor panel earth bus with 2 nos 8 SWG copper or 6 SWG GI earth wire.

Contractor shall also submit four sets of installation and maintenance manual.

**L.T. CABLES & WIRE**

a) **Wires**

The design manufacture, testing and supply of single core **LEAD FREE FRLS PVC** insulated 1.1 KV grade multi-stranded twisted wires under this specification shall comply with latest edition of following standards.

- **IS : 3961**  
  Current rating for cables.

- **IS: 5831**  
  PVC insulation and sheath of electric cables.

- **IS : 694**  
  PVC insulated cables for working voltage upto and including 1100 volts.

- **IEC: 754(i)**  
  FRLS PVC insulated cable.

Copper multi-stranded twisted conductor FRLS PVC insulated wires shall be used in conduit as per item of work.

The wires shall be colour coded R Y B, for phases, Black for neutral and Green for earth.

Progressive automatic in line indelible, legible and sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of wire.

The material & insulation of wires shall be **RoHS compliant** (Reduction Of Hazardous Substance) and shall comply the following directives:

- EU Directive 94/62/EC and 2004/12/EC (amendment)
- EU Directive 91/338/EEC

**Summary on related directives**

<table>
<thead>
<tr>
<th>Directive Ref.</th>
<th>Date</th>
<th>Objective</th>
<th>Remarks</th>
</tr>
</thead>
</table>
### Restriction of the use of certain hazardous substances in electrical and electronic equipment (EEE)

<table>
<thead>
<tr>
<th>Directive</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
</table>
| 2002/95/EC | 27Jan03 | 6 banned materials included Pb (Lead), Hg (mercury), Cr6+ (Hexavalent Chromium), Cd (Cadmium) and Flame Retardants- Polybrominated Biphenyls – PBB 1000ppm & Polybrominated Diphenyls Esters- PBDE 1000ppm.  
• Max. conc. value - 0.1% by weight in homogeneous material for Pb, Hg, Cr6+, PBB/PBDE  
• Max. conc. value - 0.01% weight in homogenous material for Cd. |
| 94/62/EC 2004/12/EC (amendment) | 20Dec94 2Nov04 | The targets defined are the following:  
• Recovery of minimum 60% by weight of the packaging waste  
• Recycling of at least 55% and a maximum 80% by weight of the totally of packaging materials, with a material-specific minimum recycling rate for plastic of 22.5%  
• Max. sum of concentration levels of Pb, Cd, Hg and Cr6+>100 ppm by weight |
| 91/338/EEC | 18Jun94 | The cadmium content (expressed as Cd metal) exceeds 0.01 % by mass is prohibited in the finished products or components of products manufactured from polymers or copolymers of vinyl chloride and stabilized by substances. |

### b) Cables

The design, manufacture, testing and supply of the cable under this specification shall comply with latest edition of following standards:
IS: 8130 Conductors for insulated electric cables and flexible cords.
IS: 7098 XLPE insulation and sheath of electric cables.
IS: 3975 Mild steel wires, strips and tapes for armouring cables.
IS: 7098 Current rating of cables.
IS: 7098 XLPE insulated (heavy duty) electric cables for working voltage upto and including 1100 volts.
IS: 424-1475(F-3) Power cable-flammability test.

Specification for cross-linked polyethylene insulated XLPE sheathed cable for working voltage upto 1.1 KV.

Specification for XLPE insulated (heavy duty) electric cables for working voltages upto and including 1100 volts.

ASTM-D: 2863 Standard method for measuring the minimum oxygen concentration to support candle-like combustion of plastics (Oxygen Index).

ASTM-D: 2843 Standard test method for measuring the density of smoke from the burning or decomposition.

IEEE : 383 Standard for type of test Class-IE, Electric cables, feild splicers and connections for power generation station.


IS : 10418 Cable drums.

c) Technical Requirements:

i. The cables shall be suitable for laying in racks, ducts, trenches conduits and under-ground buried installation with uncontrolled back fill and chances of flooding by water.

ii. They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating condition.

iii. The aluminium/copper wires used for manufacturing the cables shall be true circular/sector in shape before stranding and shall be of uniformly good quality, free from defects. The conductor used in manufacture of the cable shall be of H2 grade.

iv. The cable should withstand 25 KA for 0.5 sec with insulation armour insulated at one end. Bidder shall furnish calculation in support of capability to withstand
the earth fault currents. The current carrying capacity of armour and screen (as applicable) shall not be less than the earth fault current values and duration.

v. The fillers and inner sheath shall be of non-hygroscopic fire retardant materials and shall be suitable for the operating temperature of the cable. Filler and inner sheath shall not stick to insulation and outer sheath.

vi. Progressive automatic in line indelible, legible and sequential marking of the length of the cable in metres at every one metres shall be provided on the outer sheath of all cables and at every 5 metre ‘FRLS’ marking in case of ‘FRLS’ cables.

vii. Strip/Wire armouring following method (b) mentioned in IS: 3975 shall only be acceptable. For single core cable aluminium wire armouring shall be used.

viii. Allowable tolerance on the overall diameter of the cables shall be + 2mm.

ix. The normal current rating of all XLPE insulated cables shall be as per IS: 7098.

x. A distinct inner sheath shall be provided by pressure extrusion process for all multicore armoured and unarmoured cables as per IS: 5831.

xi. Outer sheath shall be provided by extrusion process as per IS: 5831

xii. The breaking load of armour joint shall not be less than 95% of that armour wire. Zinc rich paint shall be applied on armoured joint surface.

xiii. In plant repairs to the cables shall not be accepted.

xiv. All the cables shall be supplied in non-returnable drums as per IS: 10418.

d) In Case of FRLS Cables

i) The outer sheath of cables shall have an oxygen index of not less than 29 as per ASIMD: 2863.

ii) The maximum acid gas generation by weight as per IEC: 754 (i) shall not be more than 20% for outer sheath material of all cables. Bidder shall also guarantee the maximum theoretical acid gas generation with 20% by weight of outer sheath.

iii) The cables outer sheath shall meet the requirement of light transmission of 40% (minimum and shall be tested as per ISTMD: 2843). In case the test for light transmission is conducted as per ASTME: 662. The bidder shall furnish smoke density values as per this standard and shall co-relate the anticipated light transmission when tested as per ASTMD: 2843.

iv) The cable shall pass the fire resistance test as per SS: 42, 41, 475 (I) and flammability test as per EEE: 383.

e) Inspection:
All cables shall be inspected on receipt of the same at site and checked for any damage during transit.

f) Joint in Cables

The contractor shall take care that the cables received at site are distributed to various locations in such a manner as to ensure maximum utilisation and avoidance of cable jointing. Cable shall be rechecked before cutting in lengths, where the joints are unavoidable, and the location of such joints shall be got approved from the DGHS/HITES. The joints shall be done by qualified jointer strictly in accordance with manufacturer’s instruction/drawings.

g) Joint Boxes for Cables

The cable joint boxes shall be of appropriate size suitable for type of cable of particular voltage rating.

h) Jointing of Cables

All straight through joints shall be done in epoxy mould boxes with epoxy resins. Straight through joints shall not be permitted unless the length of run is in excess of cable drum.

End terminations of cables more than 1.1 KV grade shall be done with epoxy mould boxed and epoxy resin. Cable glands shall be 1.1KV grade double compression type and made to tin plated heavy-duty brass casting and machine finished. Glands shall be of robust construction capable of clamping cable and cable armour, firmly without injury of cable.

All washers and hardwares shall be made of brass tinned. Rubber components used in the glands shall be made of neoprene of tested quality.

Cable lugs shall be tinned copper/aluminium solderless crimping type conforming to IS: 8309 suitable for aluminium or copper conductor.

Crimping of terminals shall be done by using Corrosion inhibitory compound, with crimping tool.

Fire resistant paint has to be applied 1 Metre on either side of cable joint.

The contractor shall liaise fully with all other contractors to achieve an efficient and properly coordinated installation where equipment has to be re-positioned due to lack of site liaison; no extra cost shall be incurred by the HITES.

i) Testing of Cables

Cables shall be tested at factory as per requirement of IS: 7098 Part-I. The tests shall incorporate routine tests, type tests and acceptance tests. Prior to laying of cables, following tests shall be carried out:
i) Insulation test between phases and phase to earth for each length of cable before and after jointing.

On completion of cable laying work, the following test shall be conducted in the presence of Engineer-in-charge/HITES/ DGHS.

a. Insulation resistance test (Sectional and overall) 1000/5000V depending upon the voltage grade of cable.

b. Continuity resistance test.

c. Sheathing continuity test.

d. Earth test.

j) Laying of Cable

The cable drum shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming links. At all changes in directions in horizontal & vertical places, the cable shall be bent with a radius of bend not less than 8 times the diameter of cable.

The cable of 1.1KV grade shall be laid not less than 750 mm below ground level in a 375mm wide trench (throughout), where more than one cable is to be laid in the same trench, the width of the trench shall be increased such that the interaxial spacing between the cables except where otherwise specified shall at least be 150mm minimum or as per site requirements or as approved by the Engineer-in-charge. Where single core cables are used in multiphase systems, the cables shall be installed in trefoil where possible.

In case the cables are laid in vertical formation due to unavoidable circumstance the depth per tier shall be increased by 200 mm (minimum). Cable shall be laid in reasonably straight line, where a change in direction takes place a suitable curvature shall be i.e. either 12 times the diameter of the cable or the radius of the bend shall not be less than twice the diameter of the cable drum or whichever is less. Minimum 3-meter long loop shall be provided at both sides of every straight through joint & 3 meters at each end of cable or as directed at site.

Greater care shall be exercised in handling the cable in order to avoid forming ‘Kinks’. The cable drum shall be conveyed on wheels and the cable unrolled in right direction as indicated on the drum by the manufacturer. The cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains.

Cables laid in trenches in single tier formation, 10 cms. All around sand cushioning is provided below and above the cable before a protective cover is laid. For every additional vertical tier. The 30cm of sand cushion are provided over the initial tier. The cable shall be protected by 2nd class bricks of size not less than 230x115x75mm, stone tiles/RCC curved channel be placed on top of the sand breadth wise for the full length of the cable and where more than one cable
is to be laid in the same trench the brick shall cover all cables and project at least 8 cms. Over the outer sides of the end cables.

Filling of trenches shall be done after the sand cushioning and laying of tiles or bricks are carried out to the satisfaction of the Engineer-in-charge (Refer drawing). Back fill for trenches shall be filled in layer not exceeding 150 mm. Each layer shall be properly rammed & consolidate before laying the next layer.

PVC pipe shall be provided for all road crossing. The size of the pipe shall be according to the cable and a minimum 100mm dia. pipe shall be provided. The pipe shall be laid in ground with special arrangement and shall be cement jointed and concreting with 1:5:10 shall be made as per relevant IS with latest amendment. Location of cables laid directly underground shall be indicated by cable marker at an interval of 30 meters & with change of direction. Aluminium strip cable tag of 20mm wide with engraved tag no. shall be provided at both ends of cable.

Where the cables are to be laid in ducts (pucca trenches) in side the building, they will have to be laid on GI rack/ on GI cable trays grouted in walls trenches. Cables sizing through floors shall be protected from mechanical damage by a steel channel to a height of one meter above the floor where cable pass through wall they shall be sleeved with PVC/steel conduit.

Where the cables are laid in open (in building) along walls, ceiling or above false ceiling, cable rack (ladder type) or cable tray shall be provided. The size of the cable tray or rack shall depend on the number of cables to pass over that rack. Cable tray/rack shall be properly supported through wall/ceiling according to the site conditions. Cable laid on tray & riser shall be neatly dressed &clamped at an interval of 1000 mm & 750mm for horizontal & vertical cable run respectively either side at each bend of cable. All power cables shall be clamped individually & control cables shall be clamped in groups of three or four cables. Clamps for multicore cables shall be fabricated of 25x3 GI flats. Single core power cable shall be laid in trefoil formation & clamped with trefoil clamps made of PVC/fibre glass.

Cable openings in wall/floor shall be sealed by the contractor suitably by hession tape & bitumen compound or by any other proven to prevent ingress of water.

After the cables are laid, these shall be tested as per IS and the results submitted to Engineer-in-charges/Engineer and in case the results found unsatisfactory, all the repairing/ replacing of cables will be done by the contractor free of charge.

**k) Fire Seal System**

i) All the floor/wall opening provided for cable crossing shall be sealed by fire seal system.

ii) The fire proof sealing system shall fully comply with the requirements of relevant IS/BS: 476 Part-B. The fireproof seal system shall have minimum two hour fire resistance rating.
iii) The fire proof seal system shall be physically, chemically, thermally stable and shall be mechanically secured to the masonry concrete members. The system shall be completely gas and smoke tight, antirdent and anti-termite.

iv) The material used in fireproof seal system shall be non-toxic and harmless to the working personnel.

v) Type of fireproof seal system shall be foaming type or flamemastic type compound or approved equivalent.

After laying and jointing work is completed, high voltage test should be applied to all cables to ensure that they have not been damaged during or after the laying operation and that there is not fault in the jointing.

Cables for use on low and medium voltage system (1.1KV grade cables) should withstand for 15 minutes a pressure of 3000V DC applied between conductors and also between each conductor and sheaths. In the absence of pressure testing facilities it is sufficient to test for one minute with a 1000V insulation tester In case the test results are unsatisfactory the cost of repairs and replacements and extra work of removal & laying will be made good by the contractor.

Cable shall be installed so that separation shown in the table below are observed.

<table>
<thead>
<tr>
<th>HV Cable (11 KV/ 33 KV)</th>
<th>HV Cable (11 KV/ 33 KV)</th>
<th>50 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELV &amp; LV 230 V/433 V</td>
<td>ELV &amp; LV cable 230 V/433 V</td>
<td>Equal to the diameter of the bigger cable.</td>
</tr>
<tr>
<td>HV cables (11 KV/33 KV)</td>
<td>ELV &amp; LV cables 230 V/433 V</td>
<td>300 mm</td>
</tr>
<tr>
<td>LV cables 433 V</td>
<td>Telephone/Instrument cable</td>
<td>350 mm</td>
</tr>
<tr>
<td>All cables</td>
<td>All hot pipe work</td>
<td>200 mm</td>
</tr>
</tbody>
</table>

1) Quality Assurance

Quality Assurance shall follow the requirements of DGHS/ HITES as applicable. Quality Assurance involvement will commence at enquiry and follow through to completion and acceptance thus ensuring total conformity to Purchaser's requirements.

m) Deviations

Deviation from specification must be stated in writing at the quotation stage.
In absence of such a statement, it will be assumed that the requirements of the specifications are met without exception.

n) **Spares for Commissioning Including Consumables**

The manufacturer/tenderer shall also supply a complete list of commissioning spares and tools and consumables. The same shall be included in the bid price. No extra payment shall be made on account of non-availability of spares during commissioning.

**70. CABLE TRAY**

**71. Ladder Type Cable Tray**

Ladder type cable tray shall be fabricated out of double bended channel section longitudinal members with single bended channel section rungs of cross members welded to the base of the longitudinal members at a centre to centre spacing of 250 mm. The channel sections shall be supplied in convenient lengths and assembled at site to the desired lengths. These may be galvanized or painted to the desired lengths.

**72. Perforated Type Cable Tray**

i. The cable tray shall be fabricated out of slotted/perforated G.I. Sheet as channel section single or double bended. The channel section shall be supplied in convenient length and assembled at site to the desired lengths. All cable trays shall be hot dipped galvanized only as per relevant IS Codes.

ii. Typically, the dimensions, fabrication details etc. are shown in CPWD General Specification for Electrical Works - Part II -External, 1994 as amended up to date. The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section.

iii. Two coupler plates, each of minimum 200mm length, shall be bolted on each of the two sides of the channel section with 8mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler plates and cable tray shall be scraped and removed before the installation.

iv. The maximum permissible uniformly distributed load for various sizes of cables trays and for different supported span are as per CPWD General Specification of Electrical Work Part II -1994. The sizes shall be specified considering the same.

v. The width of the cable tray shall be chosen so as to accommodate all the cable in one tier, plus 30 to 50% additional width for future expansion. This additional width shall be minimum 100mm. The overall width of one cable tray shall be limited to 800mm.
vi. Factory fabricated bends, reducers, tee/cross junctions, etc. shall be provided as per good engineering practice. (Details are typically shown in figure 3 of CPWD General Specification of Electrical Work Part II -1994) or as amended up to date. The radius of bend, junctions etc. shall not be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

vii. The cable tray shall be suspended from the ceiling slab with the help of 10mm dia GI rounds or 25 mm X 5 mm flats at specified spacing as per CPWD General Specification of Electrical Work Part II -1994 or as amended up to date. Flat type suspenders may be used for channels up to 450mm width bolted to cable trays. Round suspenders shall be threaded and bolted to the cable trays or to independent support angles 50mm x 50mm x 5mm at the bottom end as specified. These shall be grouted to the ceiling slab at the other end through an effective means, as approved by the PMC/Consultant to take the weight of the cable tray with the cables.

viii. The entire tray (except in the case of galvanized type) and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust, and finished with two coats of spray paint of approved make synthetic enamel paint.

ix. The cable tray shall be bonded to the earth Terminal of the switch bonds at both ends.

x. The cable trays shall be measured on unit length basis, along the center line of the cable tray, including bends, reducers, tees, cross-joints, etc, and paid for accordingly.

xi. Dimensions of Cable Trays shall be as following:

<table>
<thead>
<tr>
<th>Sr</th>
<th>Width</th>
<th>Depth</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100 mm to 300 mm</td>
<td>50 mm</td>
<td>2 mm</td>
</tr>
<tr>
<td>2</td>
<td>375 mm to 450 mm</td>
<td>62.5 mm</td>
<td>2 mm</td>
</tr>
<tr>
<td>3</td>
<td>600 mm to 900 mm</td>
<td>75 mm</td>
<td>2 mm</td>
</tr>
</tbody>
</table>

SANDWICH BUS DUCTS/ TRUNKING, RISING MAINS

73. SCOPE:

These specifications are intended for design, manufacturing, Supply, Installation, testing & commissioning of 3 Phase 3 Wire / 3 Phase 4 Wire (100% Neutral ) / 3 Phase 5 Wire Sandwich type Aluminum Busbar Trunking System.
74. SYSTEM DETAILS:

The Busbar Trunking System shall be suitable for operational Voltage of 415V / 690V / 1000V with supply frequency of 50Hz, minimum insulation voltage of 1100V & impulse withstand voltage of 12 kV.

75. STANDARDS:

The Busbar Trunking System shall be designed to comply in accordance with the following international standards,

IEC 61439 – Part 1 : Low voltage switchgear & controlgear assembly-General rules
IEC 61439 – Part 6 : Busbar Trunking Systems (busways)
IEC 60529 : Degree of protection
IS 8623 – Part 2 : Specification for Low Voltage Switchgear & Controlgear Assemblies
IS 1893 – Part 1 : Criteria for Earthquake Resistant Design of Structures
IEEE 693:2005 : High Seismic Qualification Level

Wherever required and specified, the Busbar Trunking System shall conform to Fire Rating of 600 deg C for 2 Hours.

Busbar Trunking System should also have Seismic Zone-5, Flame Propagation and Fire Resistance certification.

76. MANUFACTURER:

The manufacturer must have an established track record in design and manufacture of sandwichbusbar trunking system, and must have supplied busbar trunking systems for at least 20 years.

77. DESIGN & CONSTRUCTION REQUIREMENTS:

78. BUSBARS:
a. The busbars should be made of high conductivity electrical grade Aluminum with conductivity >60%

b. Purity of Aluminum conductor should not be less than 99.6%

c. Aluminum busbars should be Tin plated at the joint area

d. Provision for mounting external earth strip to be provided on both side of busduct. 2 Nos. Copper earth strips of appropriate size shall be provided for the complete run of bus bars enclosure.

79. INSULATION:

a. Each bus bar shall be individually insulated by means of Multi layer Class-F Insulation; Each layer shall have withstand breakdown voltage of minimum 6 kV.

b. The insulation material used shall be of minimum Class F (155 deg. C)

c. Insulation must be Halogen free & RoHS compliance

80. HOUSING:

The housing shall be made of minimum 1.6 mm electro-galvanized sheet steel, epoxy powder coated with RAL7032 shade.

Enclosure must be dust & vermin proof

IP rating of indoor busduct must be IP-54 / IP-55 & Outdoor busduct should be IP-65 / IP-66 with canopy.

81. JOINTS:

a. The joint design shall have inbuilt provision of absorbing expansion & contraction of 12mm per joint during operation.

b. The joint insulation must be of single piece moulded design of thermoset material for longer life and higher temperature withstand & better insulation property.

c. The joint construction must allow +/- 3mm adjustment at the time of installation, for ease of adjusting to site measurement variations.

d. The joint bolt must be insulated with a bolt insulator. The bolt insulator must be of molded one piece.

e. The joint design shall have inbuilt provision to prevent excessive insertion of busduct which can damage the bolt insulator.

f. The busbar ends shall not have holes or slots at the joints to avoid reduction in cross section area which will lead to temperature increase.
The electrical continuity shall be through pressure plates, achieving a high contact area of joint cross section and expansion capability.

g. It shall be possible to install and remove the joints without disturbing the adjacent feeder section

h. Joint set should have insulators with temperature withstand capacity of class-F

82. PLUG-IN UNIT / TAP OFF UNITS:

a. Plug in boxes will be of draw out type. Contacts will be of silver plated copper and spring loaded. Earth connection will be the first to make and last to break during insertion and with drawl. Plug in boxes will be made from 1.6 mm CRCA sheet steel powder coated.

b. Each section of Bus Bar enclosure plug in ports spread at interval of approximately 600 mm for the insertion of plug in boxes.

c. Inside the plug in Boxes MCCB will be located as per requirements. The operating handle will be interlocked with plug in box cover so that MCCB can be operated only with the suitable cover in closed position. The plug in box will be interlocked with bus bar trunking so that it cannot be inserted or removed with the plug in box lid open. MCCB will be of 4 pole type. Short circuit breaking capacity of MCCB in Plug in Box should be same as that of bus trunking i.e. 50 KA.

d. When the MCCB in the Plug-in unit is in ‘ON’ position, the operator should not be able to open the door.

e. The design of plug-in units shall be such that, the PE conductor shall be of ‘First-Make’ ‘Last-Break’ type.

f. The Plug-in unit will be suitable for accommodating MCCBs or other accessories, as required. The Plug-in unit should allow the flexibility of accommodating different reputed MCCB makes, to be mutually agreed depending on the tender requirements.

g. Plug-in unit must achieve IP-54 protection

h. Plug-in units should be plug-in type up to 400A & Bolt-on Type from 630A

i. It should be possible to offer Bolt-on Type Tap-off Box for 100A & higher ratings to withstand vibration due to crane movement, heavy machines in industries

83. ROUTINE & TYPE TESTS:
a. The busduct shall be type tested at a reputed test laboratory (certified by ASTA or ERDA) for the tests as per IEC-61439 Part-1 (Low voltage switchgear & controlgear assembly- General rules) & Part 6 (Bus bar trunking systems & bus ways)

b. Short circuit testing of busduct should be for duration of 1 Sec. Neutral & Earth conductor should also be tested for 60% short circuit rating of phase conductor

c. Degree of ingress protection (IP rating) shall also be tested at any reputed independent laboratory as per IEC-60529

d. Dielectric test.

e. Busduct should be tested for minimum Seismic Zone-4 & High Seismic Qualification level as per IEEE:693

84. INSTALLATION:-

The Bus Section shall be joined together with flanges and tie bolts. Bus trunking shall be suspended at a uniform height as per site conditions above floor/Ground level with suitable MS suspenders and MS supports duly Hot dip Galvanised.

TECHNICAL SPECIFICATIONS OF AUTOMATIC TRANSFER SWITCH

Scope

In order to ensure the long-time continuous power supplying for the critical loads, this this needs to have ATS. The critical parameters and technical features requirements of the ATSS are listed as below.

Codes and Standards

The automatic transfer switches and accessories shall conform to the requirements of:

EN 60947-6-1 / IEC60947-6-1: transfer switching
EN60947 -3 / IEC60947-3: Suitable for Isolation
EN55022: Radiated and Conducted Emission, Class A
EN61000-3-2: Harmonic Current Emission, Class A
EN61000-3-3: Limits of Voltage fluctuation and Flicker
EN 61000-4-5: Immunity to Surge

EN 61000-4-4: Immunity to Electrical Fast Transient:

EN61000-4-2: Immunity to Electrostatic Discharge

EN61000-4-3: Immunity to Radiated Electric Fields

EN 61000-4-6: Immunity to Continuous Conducted Interference

Technical details of Automatic Transfer Switch

The ATS must comply with the IEC 60947-6-1 standard, and pass strict tests in a third party test lab. A valid type test report should be made available to prove that ATS complies with the latest IEC 60947-6-1 standard. The ATS must comply to minimum AC33B utilization category without derating of operational current (Ie). The mechanism should have reliable electrical and mechanical interlock, which can prevent two sources from connecting simultaneously. The main contacts can operate at Three operation positions. When operating at three operation positions mode, two sources can be isolated in the center-off position. An isolating position lock is required to ensure safe maintenance when operating at center-off mode. The automatic transfer switch need to be having self acting controller connected to ATS switch that performs voltage sensing, Frequency sensing, Power loss, Phase loss, under voltage, over voltage, over frequency, under frequency Transfer.

Operating voltage range (AC) need to be from 0.7% to 1.15% of nominal voltage.

Mechanical operational life need to be atleast 10,000 cycles.

Need to comply to standards for harmonic current Emission, CLASS A.

Making and breaking capacity need to be 10 times of rated operational current.

Controller

Different Optional Modes (Source I priority /No Source priority)

Controller Display Having Indicator - programming the features and settings, Switch position indicator lights, Source acceptability indicator lights on the front door panel.
Controller should be capable of detection of under and over voltage settings on source I and source II, Under and over frequency settings on source I and source II, Voltage unbalance detection between phases, under frequency transfer, over frequency transfer.

High frequency switching power supply, and wide power voltage range

Diagnosis fault intelligent with self – protection function (Motor-Blocked)

Center-off with time delay and center-off with protection - The center-off time delay can be set to avoid large current rushes to inductive loads, Center-off with protection is available to protect critical loads (e.g.Fire Pump).

**Power Switching**

Rotating dual contactor design extinguishes the arc quickly and effectively

Clamping contactors are self cleaning wiping action type

High short circuit capability

**Switching Mechanism**

Automatic or manual operation provided

Unique contact design avoids contact bounce

Electrical and mechanical interlocks prevent both sources being connected simultaneously

Innovative motor breaking technique, provides precision control

Cast steel bevel gear mechanism provides for high transmission efficiency.

<table>
<thead>
<tr>
<th>Operational Current (I_e)</th>
<th>16A to 800A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated insulation voltage U_i (V)</td>
<td>800-1000</td>
</tr>
<tr>
<td>Rated impulse withstand voltage U_imp (kV)</td>
<td>8-12</td>
</tr>
<tr>
<td>Rated operational</td>
<td>220, 230, 240, 380, 400, 415</td>
</tr>
</tbody>
</table>
### Voltage Ue (V) Table

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated frequency (Hz)</td>
<td>50/60</td>
</tr>
<tr>
<td>Rated Short-Time Withstand Current Icw (kA)</td>
<td>10kA (0.1s) up to 160A, 15kA (0.1s) up to 250A, 25kA (0.1s) up to 400A, 40 kA (0.1s) up to 800A.</td>
</tr>
<tr>
<td>Rated Short-Circuit Making Capacity Icm (kA)</td>
<td>17kA (up to 160A), 31.5kA (up to 250A), 65 kA (up to 400A), 80 kA (up to 800A)</td>
</tr>
<tr>
<td>Making and breaking capacities</td>
<td>10 Ie</td>
</tr>
<tr>
<td>Mechanical operational performance</td>
<td>10,000</td>
</tr>
<tr>
<td>Utilization categories</td>
<td>AC-32A, AC-33B</td>
</tr>
</tbody>
</table>

### SECTION-IV-TECHNICAL SPECIFICATIONS FOR DG SETS

#### DIESEL GENERATOR SETS & ASSOCIATED WORK

**1. SCOPE OF WORK:**

This specification covers the design, manufacture, assembly, packing, dispatch, transportation, supply, erection, testing, commissioning, performance and guarantee testing of Diesel Gen-Sets with Acoustic Enclosure, complete in all respects with all equipment, fitting and accessories for efficient and trouble free operation as specified here under. All DG Sets shall be provided with Hospital Type Silencers.

Silent Type Diesel Generator Set with suitable batteries, electrical panels, Radiator cooling system, Exhaust System (as per the requirement), day tank fuel system, fuel piping etc. as per requirement.

a. The Scope of work shall also include labour, tools, tackles and plants, hardware and consumables, steel fabrication and items as prescribed below:

b. Diesel Engine and Alternator set complete with base frame and accessories.

c. DG Set shall be with PCCM / Synchronizing relay suitable for auto /manual / By pass arrangements.

d. Engine mounted engine control integral panel duly wired upto terminal box for engine safeties with sensors and protection for inter facing with PLC/Microprocessor based relay.
e. Fuel Oil system including day service oil tank, piping, valves, filters etc. from engine to service day oil tank.

f. Lube oil system with piping etc. (Pre-lube oil pump with controller if required).

g. For DG Sets upto & including 1010 KVA Rating: Radiator Cooled System without Cooling Towers.

h. For DG Sets above 1010 KVA Rating: Cooling system with Heat Exchanger, suitable rating Cooling Towers complete with makeup water tanks. GI B class Water Pipes of suitable size with valves & bends etc shall be provided between DG Sets & Cooling Towers.

i. Exhaust emission shall meet latest CPCB norms without catalytic converter or online scrubber and residential silencer, exhaust piping with mineral wool insulation and aluminum cladding as called for.

j. Steel fabricated structure/support/hanger including fixing, grouting and bolting etc.

k. Painting of steel work.

l. LT Termination Box shall be suitable for suitable size Sandwich busducts through flexible tinned copper busbars of suitable ratings.

m. Copper Control cabling between DG sets and respective LT Panels

n. Exhaust Gas Pipes MS C Class, 6 mm thick with all accessories and hardwares. Height of Exhaust pipes shall be provided as per relevant CPCB and CPWD norms.

o. MS Stack structure for supporting DG Exhaust Pipes duly painted with 2 coats of red-oxide primer & enamel paint of approved shade.

p. All DG Sets shall be provided adequate shading with polycarbonate sheets supported on MS structure duly painted.

q. Body & Neutral earthing of DG Sets complete with earth pits and earth strips/wire etc as per IS-3043.

r. All DG Sets shall be tested by an independent test laboratory ICAT (Manesar)/ARAI, Pune to ascertain that DG Set will generate the net nominal full load at the stipulated ambient temperature conditions. Test Certificates for DG Sets shall be produced.

2. CODES & STANDARDS

The design, construction, manufacture, inspection, testing and performance shall comply with all the currently applicable statutes, safety codes, relevant Bureau of
Indian Standard (BIS), British Standards (BS), International Electro Technical Commission (IEC) publication, standards amended up to date.

Some of the applicable standards are listed below:

<table>
<thead>
<tr>
<th>(A) ISO 8528</th>
<th>Generating Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part – I</td>
<td>Application, rating and performances.</td>
</tr>
<tr>
<td>Part – II</td>
<td>Engines</td>
</tr>
<tr>
<td>Part – III</td>
<td>A.C. Generator for generating set</td>
</tr>
<tr>
<td>Part – IV</td>
<td>Control Gear &amp; Switch Gear</td>
</tr>
<tr>
<td>Part – V</td>
<td>Generating Sets</td>
</tr>
<tr>
<td>Part –VI</td>
<td>Test Methods</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(B) IS 10000 (Naturally Aspirated)</th>
<th>Engines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part - I 1980</td>
<td>Methods of tests for I.C. Engines Part - I- Glossary of terms relating of test methods</td>
</tr>
<tr>
<td>Part - IV- 1980</td>
<td>Declaration of power, Efficiency, fuel consumption, lubricating oil consumption.</td>
</tr>
<tr>
<td>Part - VII- Performance Tests</td>
<td>Test for smoke level, limit and correction for smoke level for variable speed.</td>
</tr>
<tr>
<td>Part - X</td>
<td></td>
</tr>
<tr>
<td>ISO – 3046</td>
<td>Performance, Torsional vibrations.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(C) IS 4889/BS – 269</th>
<th>Alternator</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>For declaring efficiency of electrical machines.</td>
</tr>
<tr>
<td>IS 4722 - 1992</td>
<td>Capability of machine to withstand over current / overload.</td>
</tr>
<tr>
<td>IS- 13364 Part I 1992</td>
<td>Alternator - Voltage Regulations upto 20 KVA</td>
</tr>
<tr>
<td>IS- 13364 Part II 1992</td>
<td>Alternator - Voltage Regulations above 20 KVA to 80 KVA</td>
</tr>
</tbody>
</table>
IEC 34-1 – 1983 | Rotating Electrical machines - Rating & Performance
---|---
IP - 21 | IS - 4691/85 | Alternator (Degree of Protection)

(D) **Acoustics Enclosure**

| IS - 8183 | Insulation material for sound absorption.
| ISO 3744 | 1998 (E) | Acoustics - Determination of sound power levels of noise sources.

(E) **Control Panel / AMF Panel**

| IS - 2147 1962 | Degree of protection.
| IS – 4722 | H.V. testing for Panel

### 3. DESIGN

The design and workmanship shall be in accordance with the best engineering practices, to ensure satisfactory performance and service life. The equipment offered by the contractor shall be complete in all respects. Any material or accessories, which may not have been specifically mentioned, but which are usual and necessary for the satisfactory and trouble free operation and maintenance of the equipment shall be provided without any extra cost to the purchaser.

The DG Sets shall be mounted on suitable anti-vibration mountings of reputed make to prevent transfer of vibration to the foundation and structures. The DG Set equipment shall be tropicalised and shall be suitable for operating at a hot humid atmosphere at an ambient temperature of 50 deg. C. Any replacement of such item with material and labour will be carried out free of cost within the warranty period.

The engine alternation set shall be capable of working at ambient temperature between 0°C to 50°C and relative humidity upto 95%.

The operating capacity of each set shall be arrived at after considering a load with power factor of 0.8 lagging, and after taking into consideration suitable de-rating on account of above parameters of the station.
The engine/alternator set shall be capable of taking 10% over-load for a period of one hour during any 12 hours period, while operating continuously at full rated load.

Nominal output voltage of engine/alternator set shall be 415 volts 50 Hz AC Supply with manual adjustment at all conditions of load with coarse and fine controls with a range of ± 5%.

The frequency shall be maintained at 50 Hz ± 2% for the set. The output wave-form shall be sinusoidal at all load conditions.

The engine/alternator set shall be selected for a high degree of performance with over all low fuel consumption for the normal life of the alternator set.

The engine/alternator set shall meet the requirements of all linear & non-linear loads, but over-sizing of the alternator in order to meet the non-liner characteristics of loads in not envisaged.

The Engine shall be capable to minimum 60% bulk load of the rating during transfer of the load from NO Load position without tripping.

4. SYSTEM OPERATION

The set may be idle for a long time except for periodical test whenever there is a electrical supply failure, the set may required to run continuously for period even exceeding 24 hours.

5. SYSTEM FEATURE

The entire work shall confirm to Bureau of Indian Standards safety standards; British Standards, and CPWD specifications.

6. PERFORMANCE REQUIREMENT

The equipment shall be capable of delivering power continuously at the generator Terminal, a net output not less than the specified value at 0.8-0.95 p.f. excluding auxiliary power (shall be included over and above), when operating under the site ambient conditions described in this specification. Gen Set should be capable of taking 100 % step load & it should be able to take full load in less than 25 sec. from start. (The set shall be suitable for prime duty).

The design parameters of the generator and excitation system shall be chosen that the set is stable while running at any load between no – load and full load and also during starting of motors. It should also have synchronous speed control with load sensing governing system suitable for parallel running of D.G. sets.

Engine should be heavy duty four strokes, turbo charged after cooler 'V' construction/in line electric start. Engine should have minimum lube oil change
period 500 Hrs. Bidders are required to offer the Duplex filter system for lube oil and fuel oil in case of non compliance.

The set shall have vibration limit less than 130 microns (as per BS:4999 Part – 142) & noise level shall be meet CPCB norms under all conditions of load. The set shall be dynamically balanced. The set shall be mounted directly on the inertia foundation or with foundation bolts etc. The efficient residential silencer shall be provided with or without catalytic converter on-line scrubber & the set shall meet EURO-II norms for D.G Sets, for the exhaust. Air inlet shall also be provided.

The engine shall be stationary, compression ignition, totally enclosed, water cooled, 4 stroke direct injection, cold battery starting, turbo charged and low temperature with after cooled Radiator Cooled 1500 RPM in accordance to BS 5514 and IS: 10002 complete with all accessories. The DG engine shall be suitable for quick start & should be able to pick up 100% load within optimum time.

The DG Engine & the batteries shall be designed to take up at least six starting attempts beyond which the system shall be protected by means of an over crank relay. Calculations for battery sizing and battery charger capacity shall be submitted for review of the consultants. The successful bidder will submit shop drawing of the equipments/accessories selected for this work for the approval.

7. SERVICE INTERVAL AND OPERATION

The set shall be capable of running at full load for not less than 500 hrs continuously. The change period both for the lube oil, lube oil filters shall be minimum 500 Hours of operations, in the event the change period for above consumables false short below the specified time period as above, bidders are required to quote for duplex type filters with oil make up systems.

8. DIESEL ENGINE - CONSTRUCTION

Material of construction of major parts shall be as under or as per manufacturer design.

- M.S. base frame with anti-vibration mountings.
- Crankcase – Aluminium alloys.
- Crank shaft, connecting rods –Forged Alloy Steel.
- Piston – AL alloy casting.
- Piston rings – Alloy Steel.
- Engine Block – Cast Iron
- Cylinder Liner – Cast Iron

All other material of construction shall be as per relevant standard/code.
One common base frame shall be provided for mounting the engine and alternator complete with electric suspension between D.G set and foundation bolts, leveling lines etc. as required.

All externally mounted hardware shall be high tensile steel only.

The normal speed of the engine shall be 1500 RPM and the direction of rotation shall be clearly marked on the set.

The engine shall be fitted with an exhaust gas driven turbo charger of air / water cooled type complete with its own self contained lubricating system. The turbo-charger shall be positioned at the free end of the engine preferably.

The engine shall be fitted with a charge air inter cooler of the air/water type. Air from the turbo-charger compressor passes through the inter cooler and then to the engine manifold. The inter cooler shall be of tubular construction or as per manufacturer design with aluminum bronze tubes, mild sheet steel and cast iron water headers.

Fuel injection and valves shall not require frequent adjustment while in service.

All filters like fuel, lubrication oil, by pass etc shall be provided in the engine and shall be dry, paper element type.

Starting system shall be 24V DC comprising of SMF batteries (25 plates, 360 AH capacity or as recommended by OEM), Voltage Regulator and arrangement for initial charging of batteries.

9. **Bed Plate**

The bed plate shall be fabricated from M.S. channel. The welding shall be radiographed, and the entire fabrication shall be stress relieved after welding. The bed plate shall have integral well ribbed diaphragms for supporting the main bearing housings.

10. **Crank Case**

The crank case shall be steel construction with heavy steel plates to form water compartments around the cylinder. To facilitate access for purpose of inspection, inspection ports shall be provided.

11. **Lube-Oil Priming Pump**

An A.C. motor driven intermittent operation lube-oil priming pump shall be provided. This shall also include necessary piping, fitting instruments etc. for lubrication system along with clock timers if required.

12. **Crank Shaft**

The crank shaft shall be made of high tensile strength steel forging, and shall have a suitable flange to which the flywheel shall be bolted.

The bearing journals and fillets shall be induction hardened; and fully balanced.
13. Main And Big End Bearings

The main and big end bearings shall be detachable shells of high grade bearing material, and shall be pre-finished.

14. Connecting Rods

The connecting rods shall be of high grade drop forged steel I-beam section, centre to centre length. The rods shall be rifle drilled for pressure lubrication of piston pin. The rod shall be tapered at piston pin end provided to reduce unit pressures. The piston pin of suitable diameter shall be full floating and made of tubular steel, and retained by a snap ring.

15. Cylinder Liners

The cylinder liners shall be replaceable wet liners, cast iron alloy, and provided with specially machined grooves in their bores to give an oil retaining surface. These liners shall be easily replaceable without re-boring the block.

16. Piston

The piston shall be made of forged aluminum alloy, cam ground and machined on outer surface. The piston shall be fitted with an oil scraper ring, and compression rings of hardened cast iron alloy. The piston shall be oil cooled.

17. Camshaft

The camshaft shall be of induction hardened steel alloy with gear drive, and one of this shall be provided for each block of cylinders.

18. Exhaust Manifold

The exhaust manifold shall be multi-branch, of insulated design utilizing Ni-resist casting.

19. Flywheel

The flywheel, which shall conform to requirements of NEMA/ASA/BS codes, shall be made of mild steel statically balanced after machining and shall have graduated markings around the periphery / markings for checking of the valves can also be located on the vibration damper. Barring slots shall be provided around the flywheel rim for hand-barring/ alternatively a suitable barring arrangement should be provided.

20. Governing System

The governor shall be Isochronous, electronic digital type with a steady state frequency variation of +/- .25%. The transient performance shall comply with ISO 8528-5, Class G3 requirements.
It should be possible to adjust the over speed settings on the governor by means of digital signals. Manual adjustments for over speed trip settings are not preferred.

**21. HEAT EXCHANGER**

The DG Set should be equipped with a Heat Exchanger/ Radiator for suitable operation.

**22. ALARMS/TRIP (AUDIO AND VISUAL)**

The following Alarm/Trip indications shall be provided as minimum with first stage as pre alarm & second stage as trip:

- High water temperature.
- Low lube oil pressure.
- Low fuel level.
- Low coolant level.
- Over crank

**23. OTHER AUXILIARY EQUIPMENT/SERVICES**

These shall be complete include the following:-

**24. Silencer**

Exhaust Silencer shall be residential type to reduce the noise level. Values for Pressure drop across the silencers to be indicated by the vendor.

**25. Cooling**

The engine shall be water cooled heat exchanger type or radiator cooled depending on its capacity. DG Set shall be adequately designed for continuous operation on ambient conditions at 50 deg C.

**26. INSTALLATION OF GENERATING SET**

The engine and alternator shall be mounted on specially designed common MS base plate and frame of extremely rigid welded construction, so as to provide no deflection.

The engine/alternator set shall be installed over the Dunlop-make, S-type anti-vibration cushy base in order to isolate the transmission of vibrations to the floor or building structures.

The exhaust system shall be designed and installed in such a manner that it avoids excessive stresses on the exhaust manifold of turbocharger, washing spray or any other source.
The exhaust pipe shall pass through an oversized collar, filled with glass wool when crossing floor/wall.

All exposed metal parts shall be suitably painted to prohibit corrosion under the climatic conditions at site.

The installation of fuel piping, power distribution and control panels shall be carried out in accordance with the specification of respective items.

27. DAY SERVICE FUEL TANK

Day service fuel tank shall be made of 3 mm thick MS sheet of 990 litres capacity or as OEM standard capacity for each set with all accessories such as oil level indicator, inlet pipe connection, outlet pipe connection, trough to collect spilt oil, air vent pipe with air filter, manhole with cover, low level and full level float valve arrangements with all fittings, interconnections between tanks and engine. The tank shall be provided with suitable calibration scale. The Fuel to be used for trials and acceptance tests shall be high speed diesel. First fill of 990 litres HSD per DG set required coolant and lube oil is included in the scope of this contract at no. extra cost.

28. FOUNDATION

Foundation shall be casted as per the recommendations of the manufacturer in consultation with the Supplier and as per the requirements of the site. The successful bidder shall submit detailed foundation drawings for approval from client.

29. PAINTING

The Contractor shall paint all exposed metal parts and equipment supplied by him. All sheet metal work shall undergo a process of phosphating, passivating and then sprayed with high corrosion resistant primer. The finishing treatment shall be of two coats of synthetic enamel paint of approved color. All piping shall be color coded.

30. ALTERNATOR

The alternator shall be brushless synchronous and suitable for 3 phase 415 Volts, 4 wire, 50 Hz, 0.8 PF, 1500 RPM.

The alternator shall be suitable for coupling directly to the diesel engine It shall be Drip proof, screen protected as per IP-23. The alternator shall be single bearing type & self ventilating. The alternators shall be continuously rated and shall have class ‘H’ insulation with a temperature rise restricted to that of class F designed and built to withstand tropical conditions. It shall generally conform to BS: 5000 (Part - 99) / standards listed above. The alternator shall be suitable for sustaining a 10% overload for 1 hour in any 12 hour period without injury. The terminal arrangement for alternator shall be suitable for Cable connections of adequate size to deliver the full load of the alternator.

The alternator shall also have a solid state type digital voltage regulator (D.V.R.) suitable for single running with control limits of 1% from no load to full load under
normal load changes. It shall be of static type and complete with cross current compensation. The regulator shall be provided with voltage adjusting potentiometer, and shall be complete with all alarm contacts, internal wiring, etc.

The Engine and Alternator shall be direct coupled and mounted on a common rigid fabricated steel base frame with suitable vibration isolation system.

31. EXCITOR

Self excited, self regulated and providing alternator output regulation at plus or minus 0.25%. The alternator shall be provided with a pilot-excited, permanent magnet-excited generator (PMG) for superior short circuit capabilities. Bidders to specify sustained short circuit current capabilities for up to 10 seconds.

The alternator shall be provided with sealed bearings to give minimum service life of 40,000 Hours. The Bidders to specify the maximum rating of the motor that can be started direct on line without any base load, with 50% base load, restricting the Voltage depth to 20%.

32. INSTRUMENTATION

Instrumentation shall be provided and mounted on the Generator Set to monitor the following:

- Engine Speed
- Oil Pressure
- Oil Temperature
- Water Temperature.

A Gauge Board shall be provided with all the indicators grouped together. The generator shall be provided with a microprocessor-based controller with a facility for remote start, remote annunciation, auto/manual synchronizing and remote communication capability. It should be possible to monitor the parameters of the engine and the alternator and display the status of the faults on the DG set if any and generate a complete report on the PC individually. The following minimum monitoring & protection is required for the alternators.

Alternator Monitoring

- Current. (I1, I2, I3)
- Frequency
- Voltage (L-L & L-N)
- KVA
- KVAR
- Power Factor
- Percentage alternator duty heavily i.e. actual load / KW rating.

The Generator shall be protected against the following electrical faults:
- Overload and short circuit
- Ground fault
- Over current
- Over frequency
- Under frequency
- Under Voltage
- Over Voltage
- Locked Rotor
- Reverse power protection.

It should be possible to read the data i.e. Parameters and Shutdown status locally on the D.G Set. All the above Parameters should be displayed on The Local Control Panel through appropriate meters and status on faults should be indicated through a facia annunciator. It should be possible to display all the functions as above on a personal computer.

33. EXHAUST SILENCER PIPING

**Exhaust Piping:** The exhaust silencer piping system shall be of heavy duty MS, Class-C pipes, 6 mm thick. The runs forming part of factory assembly on the engine fl exible connections up to exhaust silencer shall be exclusive of exhaust piping item. The work include necessary cladding of exhaust pipe work using 50 mm thick loosely bound resin (LBR) mattress/ mineral wool/ Rockwool, density not less than 120 kg/m3 and aluminium cladding (0.6 mm thick) for the complete portion. The exhaust pipe work includes necessary supports, foundation etc. to avoid any load & stress on turbo charger / exhaust piping. The exhaust pipe shall be run along the existing wall of the building duly clamped/supported on independent structure for which, the design and Drawing for such structure shall be got approved from the Engineer-in-charge.

Exhaust system should create minimum back pressure.
Number of bends should be kept minimum and smooth bends should be used to minimize back pressure.

Pipe sleeve of larger dia. should be used while passing the pipe through concrete wall & gap should be filled with felt lining.

Exhaust piping inside the Acoustic Enclosure/ Genset room should be lagged with asbestos rope along with aluminium sheet cladding / insulated to avoid heat input to the room.

Exhaust flexible shall have it’s free length when it is installed. For bigger engines, 2 flexible bellows can be used.

For engines up to 500 KVA, only one bellow is required. However, if exhaust pipe length is more than 7 m then additional bellow/ provision for expansion should be provided.

‘C’ Class MS pipes and long bend/elbows should be used.

The exhaust outlet should be in the direction of prevailing winds and should not allow exhaust gases to enter air inlet/ windows etc.

When tail end is horizontal, 45 Degree downward cut should be given at the end of the pipe to avoid rain water entry into exhaust piping.

When tail end is vertical, there should be rain trap to avoid rain water entry. If rain cap is used, the distance between exhaust pipe and rain cap should be higher than diameter of pipe. Horizontal run of exhaust piping should slope downwards away from engine to the condensate trap. Silencer should be installed with drain plug at bottom.

34. TESTS AT MANUFACTURER’S WORK

The following tests shall be performed at manufacture’s works prior to packing and dispatch to site:

**On DG Set**

- Maximum power load capacity.
- Maximum motor starting capacity
- Endurance test.
- Fuel consumption at full load, 50% load, 75% load and 25% load.
- Engine - Alternator cooling air flow
- Load acceptance Test

35. On the Alternator
- High voltage tests on stator and rotor windings.
- Insulation resistance of stator and rotor windings.
- Temperature rise test.
- Measurement of resistance of stator and rotor windings.
- Measurement of losses.
- Mechanical balance.
- Load rejection and over speed tests.
- Stator voltage and current tests.
- Stator phase sequence check.

36. On the Excitor

- High voltage tests on stator and rotor winding.
- Insulation resistance of stator and rotor windings.
- Temperature rise test.
- Measurement of resistance of stator & rotor winding
- Measurement of losses.
- Response ratio test.
- Over speed test.
- Mechanical Balance test.
- On the Automatic Voltage Regulator
- Sensitivity test.
- Response time test

All routine test as per IS/BS codes shall be conducted on alternator, exciter and AVR. DG Panel shall be part of Main L.T. Panel, supplied by the Owner. However DG supplier shall do the coordination and provide all the inputs required for successful operation.

37. Battery/ Electrical System
Batteries supplied with Genset are generally dry and uncharged. First charging of uncharged batteries is very important and should be done from authorized battery charging centre. Initial charging should be done for 72-80 hours.

Batteries should be placed on stands and relatively at cool place.

Battery capacity and copper cable sizes for various engine capacity are recommended as indicated in the table below. Cable sizes shown are for maximum length of 2 m. If length is more, cable size should be selected in such a way that voltage drop does not exceed 2 V. However capacity as recommended by manufacturer may be taken.

<table>
<thead>
<tr>
<th>DG Set Capacity</th>
<th>Battery Capacity (AH)</th>
<th>Cable Size (Material Copper) Sq. mm</th>
<th>Electrical System (Volts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above 500 KVA</td>
<td>360</td>
<td>70</td>
<td>24</td>
</tr>
<tr>
<td>Above 125 KVA upto 500 KVA</td>
<td>180</td>
<td>70</td>
<td>12</td>
</tr>
<tr>
<td>Above 82.5 KVA upto 125 KVA</td>
<td>180</td>
<td>50</td>
<td>12</td>
</tr>
<tr>
<td>Above 62.5 KVA upto 82.5 KVA</td>
<td>150</td>
<td>50</td>
<td>12</td>
</tr>
<tr>
<td>Above 25 KVA upto 62.5 KVA</td>
<td>120</td>
<td>50</td>
<td>12</td>
</tr>
<tr>
<td>Upto 25 KVA</td>
<td>88</td>
<td>35</td>
<td>12</td>
</tr>
</tbody>
</table>

38. Cabling & Bus Trunking

Power cabling between alternator to Main LT Panel shall be carried out as per recommended cable sizes upto DG set capacity upto 500 KVA.

As far as possible, for DG Set of capacity 500 KVA & above connection between alternator to Main LT Panel shall be through Sandwich bus trunking. For exposed/ outdoor bus trunking protection requirement should be IP-66.

While terminating cables, avoid any tension on the bolts/ busbars (if cable is specified). While terminating R, Y & B phase notations should be maintained in the alternator and LT Panel for easy maintenance. Crimped cables should be connected to alternator and control panel through cable glands.

Multi-core copper flexible stranded cable of 2.5 Sqmm size should be used for interconnecting the engine controls with the switchgear and other equipments. External wirings, when provided for remote voltage / excitation monitoring/ droop CT etc. shall be screened sheathed type.

39. Alternator Termination Links
For proper terminations between links and Cables/switchgear terminals, the contact area must be adequate. The following situations should also be avoided as they lead to creation of heat sources at the point of termination:

(i) Point contact arising out of improper position of links with switchgear terminals

(ii) Gaps between busbars / links and terminals being remedied by connecting bolt/stud In such cases the bolt will carry the load current. Normally these bolts / studs are made of MS and hence are not designed to carry currents.

Adequate clearance between busbars / links at terminals should be maintained (IS 4232 may be referred to for guidelines). Improper termination will lead to local heat generation which may lead to failure.

40. INSPECTION AND TESTING AT SITE

All pre-commissioning and commissioning test and checks shall be carried out at site. The Contractor shall be required to produce manufacturer’s test certificate for the particular batch of materials supplied to him by the manufacturers. The test carried out shall be as per the relevant standards. For examination and testing of materials and the works at site, the Contractor shall provide necessary testing and gauging equipment as required. All such testing and gauging equipment shall be tested for calibration at any approved laboratory as required by the Engineer In Charge. The Contractor shall give notice well in advance to the Engineer In Charge before commencement of any site testing. All materials like consumable stores, fuel oil grease, lubricating oil etc. required for the trails shall be arranged by the contractor. The Contractor shall make all necessary hook-ups to carry out tests at site and shall furnish necessary fuel. The complete installation should be initially started and checked out for operational compliance by manufacturer’s representative.

TRIALS (AT SITE):

41. Preliminary Trials

After completion of erection of generating sets and before carrying out main trials, preliminary site trials shall be conducted in the presence of the Engineer In Charge. Such trials shall include the checking and adjustments of all instrument relays, timers, interlocks and meters. Insulation resistance of stator, rotor and exciter windings shall be checked and reading recorded. A check shall be made for the satisfactory working of all auxiliary motors and their starting accessories supplied with the set. Diesel & lubricating oils for establishing performance at site shall be arranged by the contractor without any extra cost.

42. Main Trials

The main trials shall include over 8 hours continuous run at available load. D.G. Panel shall be tested for automatic operation by injecting proper current and voltage by a separate source. The satisfactory working of automatic operation
shall be tested and necessary adjustments shall be done for relays in the presence of the Engineer In Charge and the results shall be recorded in the test sheet at 30 minutes intervals. Alternator efficiencies as determined in works test shall be used as the basis of calculation for fuel consumption rate. A tolerance of 3% shall be allowed on the fuel oil consumption to cover possible errors in measurement.

Tests providing the satisfactory performance of all safety and operating controls shall be carried out. Governor trials shall be carried out as laid down in ISO: 3046. Alternator insulation resistance and commutation check shall be as per ISO: 3046. Starting time of sets shall be tested at least five times after sufficient time intervals to allow for cold start. On completion of tests, inspection doors shall be removed and running gears inspected and alignment checked.

Any further reasonable trial as suggested by the Engineer In Charge shall be carried out with no extra charges. All instruments, materials and labour required for carrying out the trials shall be provided by the Contractor. Test sheets of trials shall be forwarded in quadruplicate to Engineer In Charge.

43. TEST WITNESS

Tests shall be performed in the presence of Engineer In Charge. The contractor shall give at least thirty (30) days advance notice of the date when the tests are proposed to be carried out.

44. EXHAUST SILENCER PIPING

The Exhaust piping system for the DG set shall be as per CPWD Specifications meeting the requirements of CPCB Norms. The exhaust silencer piping system shall be of heavy duty MS pipes confirming to class B. Suitable length of flexible piping shall be used for connecting the exhaust piping to the engine as per the recommendation of the manufacturer. MS screws flanges and bends shall be used as per site requirements. Exhaust pipe inside the building shall be logged with heat resistive glass wool of 48 kg / meter cube and then cladded with Al. foil all along the pipe.

**Exhaust Stack Height** In order to dispose exhaust above building height, minimum exhaust stack height should be as follows:-

a. For DG Sets up to 1000 KVA - \( H = h + 0.2\sqrt{KVA} \)

   where \( H \) = Height of Exhaust stack, \( h \) = Height of building

b. For DG set above 1000 KVA - 30 M or 3M above the building height, whichever is higher

The Exhaust Piping stack shall be supported by suitable MS steel structure with twin aviation light at the top of the exhaust piping.
45. Synchronization System

The synchronization panel shall be complete in all respects for auto operation of D.G. Sets. The minimum requirement for D.G. set operation shall be as detailed below, however, the vendor shall indicate in details the additional features and facilities being offered by them.

The parallel operation of D.G. set in Synchronization mode shall be completely through Power Control Center Module (PCCM). The PCCM shall be mounted on DG SETs outside the Building (the supplying and fixing of the PCCM is in the scope of Supplying and fixing of DG vendor Set). The PLC for the further operation shall be mounted on the Synchronizing panel with SLC 5/03 processor, kw transducer & suitable input / output card, 8 channel analog card, Power Monitors – IV. The wiring between the DG Sets, PCCM and Synchronizing Panel is included in the scope.

During the parallel operation, the system take care of the load sharing i.e. active and reactive both for all the D.G. sets and issue soft commands for voltage / frequency raise / lower,

Depending upon the load requirements, the system shall start / stop the D.G. sets.

Monitoring & logging of the electrical data and events through existing P C. This will be achieved by using microprocessor based PC controller or equivalent networking kits & required hardware like GCM, modlon converter, communication cable.

Alarms and necessary remedial commands for D.G. and electrical system fault.

D.G synchronizing panels. Local Control and Manual Synchronization

(Common for all D.G. Sets Part of the Synchronizing Panel)

The minimum equipment shall be as follows:

- DG selector switch
- PLC / manual selector switch
- Double scale voltmeter
- Double scale frequency meter
- Synchronoscope
- Check synchronization relay
- Synchronization lamps
Solo parallel selector switch

Manual synchronization circuit “ON”/“OFF” selector switch

Push buttons & indicating lamps

Control PT

Mimic

The following components shall be provided for each DG Set:

a. Breaker control Switch except for DG Incomer.

b. Automatic battery charger having inbuilt Trickle /boost facility selector switch for battery charger

c. DC digital Ammeter and Voltmeter selector switch

d. Auto/Manual selector switch for priming pump

e. Breaker control switch (only for one number bus-coupler required)

f. Indicating lamps (LED type) for following:

g. R.Y.B, Phase Indication

h. D.G breaker “ON”/“OFF” spring charged

i. Neutral contactor “ON” /“OFF”

j. Engine running

k. Battery charger “ON”

l. Control supply healthy

m. Priming pump “ON” /“OFF”

n. Speed raise /low joystick

o. Voltage raise / low joystick

p. 12 window annunciator with alarm Accept/Test/Reset push buttons, Hooter.

q. Temperature Scanners for RTD and BT

r. Beacon light

s. Hour meter
t.  5 Nos. Under voltage relay for mains feeder  
u.  5 Nos. Over Voltage relay for mains feeder  
v.  Stand by Earth fault relay  
w.  Reverse power relay (reactive)  
x.  Trip circuit supervision relay  
y.  Master trip relay 5 H.P, DOL starter for oil priming pumps for D G Set  
z.  Power factor meter (Analog)  
   aa. Frequency meter (Digital)  
   bb. Ammeter (Digital)  
   cc. Voltmeter (Digital)  
   dd. KW and KVA meter (Digital)  
   ee. Kwh meter (Digital)  
   ff. D.C. Ammeter (digital)  
   gg. D.C. Voltmeter (digital)  
   hh. Breaker Control Switch for bus coupler  
   ii. Battery Charger on / off switch with boost and trickle charger facility  
   jj. Trickle / booster charger selector, switch  
   kk. Push buttons (lot)  
   ll. P. T  
   mm. Aux. Contactor (lot)  
   nn. Transducers  

46. Automatic Generator Sequencing  
   a) Automatically start & stop gen sets based on plant load or bus on process demand.  
   b) Configurable plant bus demand start / stop levels and timers.  
   c) On line engine priority sequence configurability from any synch. Unit or PC to equalize run time of all DG Sets.
47. SYNCHRONISING PANEL

The technical specification and details of the microprocessor based PLC controller for the DG set synchronizing and load sharing shall be as follows:

The microprocessor based PLC panel shall be suitable for use with AVR and electronic speed governor to protect and monitor DG sets.

Double Frequency Meter and Double Voltmeter shall be provided in synchronizing panel.

Synchrony check relay also shall be provided.

The PLC shall be provided with following features and audible alarm:

- Engine pre glow control
- Fuel solenoid control
- Engine starter control
- KVA controlled cool-down timer
- Speed monitoring
- Over speed protection
- Oil pressure monitoring, alarm and shutdown of the engine.
- Water temperature monitoring, alarm and shutdown of the engine
- Battery voltage monitoring
- Over speed monitoring and alarm.
- 3 attempt start failure alarm
- Under/Over Frequency
- Reserve Power (Inverse time delay)
- Loss of excitation
- Over current (inverse time delay)
- Loss of utility power detection
- Load surge
- Current unbalance
Construction of Drug Testing Laboratory, Kathua (J&K) Volume-IV Technical Specifications

- Voltage unbalance
- Mains Protection (vector shift, df/dt ROCO1)
- True RMS power calculations accurate control
- Configurable loading/unloading ramp rates
- Isochronous load sharing of up to 4 units using percentage based load sharing
- Base load control for optimum fuel efficiency
- Import export control using a watt transducer
- Soft utility transfer function
- Digital signal processing to eliminate harmonic issues
- Adjustable phase window, Voltage and dwell time
- Safe dead bus closing logic internal to the control
- Synchronization across generator and mains breakers
- Multiple short re-closing with adjustable time delay
- Manual voltage and speed adjusts for manual synchronizing
- VAR sharing on isolated busses using percentage based reactive load sharing
- Power factor or VAR control when base loaded
- Externally adjustable VAR or PF set point levels.
- The DG set shall start and stop automatically based on plant bus demand.

The PLC system shall be provided with built in relays for protection of the following:

- Reverse Power
- Reverse KVAR
- Over current
- Under and over voltage
- Under and over frequency
Synchronization check and earth fault relay.

The PLC system shall be suitable for load sharing by sensing active and reactive power.

The PLC system shall comprises of the following:

- Main processor unit
- Power module for power supply to the processor and the system
- Power monitor to monitor voltage, KVA, KVAR, KW, KWH, KVAH, KVARH.
- 16/32 channel Digital input module
- 16/32 channel Digital output module
- EEPROM for main processor unit
- Computer to PLC communication card with necessary cables.
- Window based operator interface Software Package
- Mounting chassis for the equipment

The microprocessor based main processor of the system shall be suitable for 128 digital I/P and 128 O/P and comprises of the following:

The main processor unit shall be suitable for operation on 24 Volts DC with integrated memory. The integrated Ram memory shall be 20 K Words for program, data and constants plus data memory and flash EPROM of 16 K works for backup application program, communication card and real time clock. 4 Nos. discrete combination module (Input/output Module) shall be provided and the same shall be suitable for operation on 24 volts DC system. Combination module shall be with 16/32 inputs and 16/32 output channels as per the actual requirement.

- 1 No. 2 slot extension rack
- 1 No. Ram back up battery unit
- 8/4 Nos. digital input module
- 8/4 Nos. digital output module

The CPU display unit shall be suitable for 4 lines of 40 characters. The display shall be with back lit LCD. Clarity shall be not less than 5 x 7 pixels. The height of the characters shall be not less than 5 mm. The data entry shall be with the help of...
24 function keys. In addition to this there shall be 10 service keys and 12 alphanumeric keys. The system shall be provided with RS 232 communication port.

48. OPERATION AND COMMUNICATION

The PLC shall monitor the bus bar load continuously. In event of mains failure the PLC shall give signal to select and start the generator, which is closer to the load sensed during the last 60 seconds. In case the load at the time of main failure is more than the highest rating DG set, the PLC shall give command to start 2 Nos. DG sets to suit the load, synchronize the sets and give command to close the breaker on the main LV panel.

If load starts reducing the PLC shall give command to turn off the DG sets through cool down timer. On restoration of main power supply, the PLC shall check the voltage and frequency and if they are stabilized and within the permissible tolerances, the PLC shall give command to shut down the DG sets through cool down timer.

The control and monitoring of the cooling tower and fan and feed pump shall be done through PLC control system. Necessary control wiring between cooling tower, pumps and PLC panel shall be carried out within the scope of work.

49. SYNCHRONIZING MODULE

The synchronizing module shall be a microprocessor based intelligent unit, which shall monitor the electrical parameters and shall able to communication with the PLC control unit in the process of synchronizing and load management. The system shall be suitable for dynamic synchronization. The synchronizing module shall be suitable for programming and set the preferred difference between DG set and bus bar.

The synchronization module shall monitor and fulfill the following conditions before the system synchronizes the DG set to mains.

Feed bank signal from the DG breaker on main LV panel that the breaker is in open condition.

- Bus bar voltage is present
- Generator voltage is present

The frequency regulator in the system shall start when the generator voltage and the bus bar voltage is over 50% of normal voltage. The voltage regulator in the system shall start when the frequency is within 90% of the normal system frequency.

The system shall close the breaker on the power panel without carrying out synchronization when all the below mentioned conditions are fulfilled.
Feedback signal from the DG breaker on main LV panel that the breaker is in closed condition.

- Bus bar voltage is present
- Generator voltage is present

The synchronizing module shall transmit all monitored electrical parameters to the PLC unit and the PLC unit shall start controlling the synchronization of the DG sets and its load management. The data logging, monitoring shall also be through a PC based BMS station.

50. SHOCK TREATMENT CHART

Shock treatment chart explaining the method of shock treatment in English, Hindi and local language shall be provided duly framed in glass in the diesel generating station.

51. WIRING

Providing conduits and drawing wires for the following:

- Control wiring between diesel generating set and the automatic mains failure panel.
- All wiring associated with the fuel oil transfer pump and including level controllers and circulating water pumps.
- All wiring associated with DC supply.
- All earthing conductors associated with this installation.
- All wiring and cables shall be PVC insulated stranded copper conductor wires and cables suitable for 660/1100 volts minimum size of wires for control wiring shall be 2.5 sq. mm and minimum size of wire for pumps shall be 4 sq.mm. The wires would be as per IS.

52. CABLES

MV cables shall be XLPE aluminium conductor armoured cables, laid in trenches between diesel generating set and DG panel. All power & control cables will be rated for 1.1 KV grade. Storing, laying, jointing procedures as same as that for the LT cables stated elsewhere.

53. TEST PERFORMANCE

54. Scope

This section lay down the procedure for conducting test on the installation. In general the procedure laid down here shall be followed. However, if manufacturer of the equipment has prescribed different procedure which is at
variance, the same may be adopted. All required artificial load, testing equipment other required material required for testing purpose shall be supplied by agency.

55. **Physical Test**

- Particulars such as name plate details of all major component equipment shall be recorded and compared with what has been offered by the contractor as per agreement.
- Level of foundation.
- Firmness of mounting.
- Verticality of installed set.
- Tightness of nuts & bolts.
- Proper installation of exhaust pipe.
- Insulation of exhaust pipe with 75 mm dia glass wool with aluminium cladding.
- Provision of guard on engine/alternator set coupling joints.
- Termination of various cables.
- Rating of various fuses.
- Termination of earth leads on neutral & body.

56. **Earth Resistance**

The resistance shall be measured by isolating the connecting earth lead in respect of all earth stations.

57. **Run Test**

The engine shall be given a test run continuously for at least six hours with alternator supplying full rated load. During this run following observation shall be recorded.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>ITEMS</th>
<th>TIME AFTER START OF RUN/TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 Hr 2 Hr 3 Hr 4 Hr 5 Hr 6 Hr 7 Hr</td>
</tr>
<tr>
<td>1.</td>
<td>Lubricating oil pressure</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Exhaust gas colour</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Speed engine</td>
<td></td>
</tr>
</tbody>
</table>
4. Output voltage
5. Load current
6. Load (KW)
7. Noise Level (DB)

58. Stator Temperature Rise Test

The alternator shall be loaded of full rated load and stator (alternator) body temperature be recorded as under at intervals of 30 minutes till such time that there consecutive readings are the same.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>TIME (Hr)</th>
<th>AMBIENT TEMP (°C)</th>
<th>STATOR TEMP (°C)</th>
</tr>
</thead>
</table>

a. The temperature rise shall be maintained within 60°C above the ambient.

Fuel Consumption Test

. Fuel consumption for half an hour shall be measured after the full load operation condition have stabilized.

. During this measurement the load shall be maintained unchanged.

. The fuel consumption shall be compared with values given in the technical particulars.

59. Over Load

- Over load test to the extent of 10% over the rated load shall be conducted immediately after the full load run test.

- The various parameters as in the case of run test shall regularly be monitored and recorded.

- After the over load test, the load shall be normalized to rated value and all parameters recorded.

60. Insulation Test

- Insulation test shall be conducted after testing the engine/alternator set at overload.

- The insulation resistance between the starter coil and from shall be measure with 5000 volts meggar.
• The insulation resistance of alternator winding shall be not below:

Rated output voltage + 1 Mega Ohms \(1000 + \text{Rated output in KVA}\)

• Insulation resistance of control wiring with 500 volts meggar shall be measure, which shall not be less than one mega ohms.

61. Regulation Test

• The voltage regulation from no laid to full rated load at 0.8 p.f. and from no load to half the rated load at 0.8 p.f. shall be measured between phase & neutral under automatic and manual regulation mode, which shall not exceed 0.5% of the nominal rated output voltage.

• In automatic regulation mode, the recovery line shall be noted which shall not exceed 3 seconds.

• The frequency of output supply of various load conditions shall be noted and recorded.

• The variation shall be compared with the accuracy standards specified.

• Change in speed of engine with change in load shall be observed and compared with standard reading for the speed governor.

62. Data Sheet

Vendors shall fill in the performance data in the block columns of the attached Data sheets.

63. Acoustic Enclosure

64. Construction Details

The Structure is fabricated using CRCA sheets of 14/16 SWG Thickness and steel members. The enclosure is fabricated on a MS Channel Frame work further strengthened by suitable cross members to make it robust and sturdy. Rock wool / Mineral wool of suitable thickness and density conforming to IS 8183 is used for acoustic insulation to reduce the sound level to 68 – 70 d b from the original sound level of 105 – 110 d b, when measured at 1mtr.distance from the D.G. Set. The acoustic enclosure consists of following:

a) Acoustic Insulation :

High density Fireproof Acoustic Enclosure Material i.e. resin bonded rock wool / fiber glass wool (75 – 100mm thick of 64Kg/m\(^3\) density) conforming to IS:8183 is provided on all doors and roof to absorb noise. The insulation material used is fire retardant. The insulation is covered with fiber glass cloth and is supported by perforated sheet. Sound attenuators / down stream silencers are provided at all openings for air inlet/outlet to facilitate free air flow but to absorb sound...
resulting in extremely low noise level. Detachable partitions are provided inside the enclosure to attain further noise attenuation of the engine.

b) Noise Suppressor:

A suitably designed absorption type Hospital noise suppressor is provided which minimize the exhaust noise of the engine.

c) Exhaust System:

The exhaust gas is taken out through a specially designed flexible pipe, which prevents any back pressure on the engine.

d) Thermal Insulation:

The exhaust system and noise suppressor is provided thermal insulation by using glass wool & covering it with Aluminum sheet. This prevents it from radiating excess heat on the engine, makes it safe for the operator and enhances aesthetics.

e) Surface Treatment:

The enclosure is surface treated and painted with high quality polyurethane epoxy paint with prior zinc oxide primer base, which makes it weather proof and suitable for outdoor application. The paint is highly resistant to acids, alkaline, salt sprays, halogens, solvents, lubricants etc and has very good dielectric properties and is resistant to abrasion and cracking.

f) Air Circulation & Ventilation System:

A suitable forced air circulation and ventilation system is designed to maintain safe operating temperatures inside the enclosure. Requisite air circulation for engine aspiration combustion and cooling is provided by means of Exhaust fans or tube axial fan driven by a 3 phase squirrel cage induction motor according to need of engine.

g) Vibration Isolation:

The engine and alternator is mounted on Anti-Vibration Mounting pads to eliminate engine vibration.

h) Hardware:

Inlet and Outlet for cable, draining of lube oil and diesel etc. are provided. The doors are gasketed with high quality EPDN gaskets to avoid leakage of sound. All doors are lockable.
CHAPTER-8

TECHNICAL SPECIFICATION-INTERNAL ELECTRIFICATION, TELEPHONE SYSTEM AND LAN NETWORKING

1. SCOPE

The electrical Installation work shall be carried out in accordance with Indian Standard Code of Practice for Electrical Wiring Installation IS: 732-1989 and IS: 2274-1963. It shall also be in conformity with the current Indian Electricity rules and regulations and requirements of the Local Electricity Supply Authority and Fire Insurance regulations, so far as these become applicable to the installation. FRLS PVC insulated Copper conductor wires will be used for points, circuit & sub-main wiring conforming to relevant IS-Codes.

Electrical work in general shall be carried out as per following CPWD Specifications with up to date amendment.

✓ Specifications for Electrical Works Part-I (Internal) by CPWD–2013 with latest revision
✓ Specifications for Electrical Works Part-II (External) by CPWD–1994 with latest revision

2. METALLIC CONDUIT WIRING SYSTEM.

3. TYPE AND SIZE OF CONDUIT

All conduit pipes shall be of approved gauge (not less than 16 SWG for conduits of sizes up to 32 mm diameter and not less than 14 SWG for conduit of size above 32mm diameter) solid drawn or reamed by welding finished with black stove enameled surface. All conduit accessories shall be of threaded type and under no circumstances pin grip type accessories shall be used. The maximum number of PVC insulated 650/1100 volts grade copper conductor cable that can be drawn in conduit of various sizes shall be as per IS Code. No steel conduit less than 20mm in diameter shall be used.

4. CONDUIT JOINTS.

Conduit pipes shall be joined by means of threaded couplers, and threaded accessories only. In long distance straight run of conduits, inspection type couplers at reasonable intervals shall be provided or running threads with couplers and jam nuts shall be provided. In the later case the bare threaded portion shall be treated with anti-corrosive preservative. Threads on conduit pipes in all cases shall be between 13 mm to 19 mm long sufficient to accommodate pipes to full threaded portion of couplers or accessories.
Cut ends of conduit pipe shall have neither sharp edges nor any burrs left to avoid damage to the insulation of conductor while pulling them through such pipes.

5. **PROTECTION AGAINST CONDENSATION.**

The layout of conduit should be such that any condensation or sweating inside the conduit is drained out. Suitable precaution should also be taken to prevent entry of insects inside the conduit.

6. **PROTECTION OF CONDUIT AGAINST RUST.**

The outer surface of conduit including all bends, unions, tees, junction boxes etc. forming part of conduit system shall be adequately protected against rust when such system is exposed to weather by being painted with two coats of oxide paint applied before they are fixed. In all cases, no bare threaded portion of conduit pipe shall be allowed. Unless such bare thread portion of conduit is treated with anticorrosive preservative or covered with approved plastic compound.

7. **PAINTING OF CONDUIT AND ACCESSORIES.**

After installation, all accessible surface (if any) of conduit pipes, fittings etc. shall be painted with two coats of approved enameled paint or aluminium paint as required to match the finish of surrounding wall, trusses etc.

8. **SURFACE CONDUIT**

Conduit pipes shall be fixed by saddles, secured to suitable approved plugs with screws in an approved manner at an interval of not more than one meter, but on either side of the couplers or bends or similar fittings, saddles shall be fixed at a distance of 30 cm from the center of such fittings. Where conduit pipes are to be laid along the trusses, steel joists etc. the same shall be secured by means of saddles or girder clips or clamps as required by the Engineer-in-charge. In long distance straight run of conduit, inspection type couplers at reasonable intervals shall be provided, or running threads with couplers and jam nuts shall be provided. Fixing Outlet Boxes Only portion of the switch box shall be sunk in the wall, the other portion being projected out for suitable entry of conduit pipes into the box.

9. **RECESS CONDUIT**

The chase in the wall shall be neatly made and of ample dimensions to permit the conduit to be fixed in the manner desired. In the case of building under construction, conduit shall be buried in the wall before plastering and shall be finished neatly after erection of conduit. In case of exposed brick/rubble masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work. Entire work of chasing the wall, fixing the conduit in chases, and burring the conduit in mortar before plastering shall form part of point wiring work.
The conduit pipe shall be fixed by means of staples or by means of saddles not more than 60cm apart or by any other approved means of fixing. Fixing of standard bends and elbows shall be avoided as far as practicable and all curves maintained by bending the conduit pipe itself with the long radius, which shall permit easy drawing in of conductors. All threaded joints of conduit pipe shall be treated with some approved preservative compound to secure protection against rust. Suitable inspection boxes to the barest minimum requirements shall be provided to permit periodical inspection and of facilitate replacement of wires, if necessary. These shall be mounted flush with the wall. Suitable ventilating holes shall be provided in the inspection box covers. Wherever the length of conduit run is more than 10 meters, then circular junction box shall be provided.

10. METAL OUTLET BOXES & COVERS.

The switch box shall be made of modular metal boxes with suitable size modular cover plates. Modular metal box shall be made of mild steel on all sides except on the front. The metal box (other than modular type) shall be made of metal on all sides except on the front. Boxes shall be hot dip galvanized mild steel. Metal boxes up to 20 x 30 cm size M.S. box shall have wall thickness of 18 SWG and MS boxes above 20 x 30 cm size shall be of 16 SWG. The metallic boxes shall be painted with anticorrosive paint before erection. Clear depth of the box shall not be less than 60mm. All boxes shall be covered from top with Phenolic laminated sheet of approved shade. These shall be of 3 mm thick synthetic phenolic resin bonded laminated sheet as base material and conform to grade P-I of IS: 2036-1994.

11. ERECTION AND EARTHING OF CONDUITS.

The conduit of each circuit or section shall be completed before conductors are drawn in. The entire system of conduit after erection shall be tested in presence of Engineer In Charge for mechanical and electrical continuity throughout and permanently connected to earth conforming to the requirement by means of special approved type of earthing clamp effectively fastened to conduit pipe in a workmen like manner for a perfect continuity between the earth and conduit.

12. NON-METALLIC CONDUIT WIRING SYSTEM

13. Scope

This chapter covers the detailed requirements for wiring work in non-metallic conduits. This chapter covers both surface and recessed types of wiring work.

14. Application

- Recessed conduit work is generally suitable for all applications. Surface conduit work may be adopted in places like workshops etc. and where recessed work may not be possible to be done. The type of work shall be as specified in individual works.

- Flexible non-metallic conduits shall be used only at terminations, wherever specified.
• **Special Precautions**
  
  i. If the pipes are liable to mechanical damages, they should be adequately protected.

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

  iii. In concealed/inaccessible places of combustible construction where ambient temperature exceeds 60 degrees C.

  iv. In places where ambient temperature is less than 5 degrees C.

  v. For suspension of fluorescent fittings and other fixtures.

  vi. In areas exposed to sunlight.

**15. Materials**

**16. Conduits**

- All non-metallic conduit pipes and accessories shall be of suitable material complying with IS 2509 : 1973 and IS 3419 : 1989 for rigid conduits and IS 9537 (Part 5) : 2000 for flexible conduits. The interior of the conduits shall be free from obstructions. The rigid conduit pipes shall be ISI marked.

- The conduits shall be circular in cross-section. The conduits shall be designated by their nominal outside diameter. The dimensional details of rigid non-metallic.

- No non-metallic conduit less than 20 mm in diameter shall be used.

- The maximum number of PVC insulated aluminium/copper conductor cables of 650/1100 V grade conforming to IS 694 : 1990 that can be drawn in one conduit of various sizes as per CPWD specification. Conduit sizes shall be selected accordingly.

**17. Conduit Accessories**

- The conduit wiring system shall be complete in all respect including accessories.

- Rigid conduit accessories shall be normally of grip type.

- Flexible conduit accessories shall be of threaded type.

- Bends, couplers etc. shall be solid type in recessed type of works, and may be solid or inspection type as required, in surface type of works.
- Saddles for fixing conduits shall be heavy gauge non-metallic type with base.
- The minimum width and the thickness of the ordinary clips or girder clips shall be as per CPWD specification.
- For all sizes of conduit, the size of clamping rod shall be 4.5 mm (7 SWG) diameter.

18. Outlets

- The switch box shall be made of either rigid PVC molding, or mild steel, or cast iron on all sides except at the front. The regulator boxes shall however be made only of mild steel or cast iron.
- PVC boxes shall comply with the requirements laid down in IS 14772 : 2000. These boxes shall be free from burrs, fins and internal roughness.
- The thickness of the walls and base of PVC boxes shall not be less than 2 mm.
- The clear depth of PVC boxes shall not be less than 60 m.
- 3 mm thick phenolic laminated sheet covers for all types of boxes shall be as per requirements.

19. Installation

20. Common Aspects for Both Recessed and Surface Conduit Works

- The erection of conduits of each circuit shall be completed before the cables are drawn in.
- Conduit Joints
  - All joints shall be sealed/ cemented with approved cement. Damaged conduit pipes/fittings shall not be used in the work. Cut ends of conduit pipes shall have neither sharp edges nor any burrs left to avoid damage to the insulation of conductors while pulling them through such pipes.
  - The Engineer-in-charge, with a view to ensuring that the above provision has been carried out, may require that the separate lengths of conduit etc.
    - after they have been prepared shall be submitted for inspection before being fixed.
    - All bends in the system may be formed either by bending the pipes by an approved method of heating, or by inserting suitable accessories.
such as bends, elbows or similar fittings, or by fixing non-metallic inspection boxes, whichever is most suitable. Where necessary, solid type fittings shall be used.

- Radius of bends in conduit pipes shall not be less than 7.5 cm. No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.
- Care shall be taken while bending the pipes to ensure that the conduit pipe is not injured, and that the internal diameter is not effectively reduced.
- Outlets
- All switches, plugs, fan regulators etc. shall be fitted in flush pattern.

21. Additional Requirements for Surface Conduit Work

- Conduit pipes shall be fixed by heavy gauge non-metallic saddles with base, secured to suitable approved plugs with screws in an approved manner, at an interval of not more than 60 cm, but on either side of couplers or bends or similar fittings, saddles shall be fixed at a closer distance from the centre of such fittings.
- Slotted PVC saddles may also be used where the PVC pipe can be pushed in through the slots.
- Where the conduit pipes are to be laid along the trusses, steel joists etc. the same shall be secured by means of saddles or girder clips as required by the Engineer in-charge. Where it is not possible to use these for fixing, suitable clamps with bolts and nuts shall be used.
- If the conduit pipes are liable to mechanical damage, they shall be adequately protected.

22. Earthing Requirements

- A protective (earth) conductor shall be drawn inside the conduit in all distribution circuits to provide for earthing of non-current carrying metallic parts of the installation. These shall be terminated on the earth terminal in the switch boxes and/or earth terminal blocks at the DBs.
- Gas or water pipe shall not be used as protective conductors (earth medium).
23. SWITCHES

All 6 and 16 Amp switches shall be modular type of 240 volts A.C. grade. All switches shall be fixed on modular metal boxes. All 6 Amp socket shall be 3 pin type and 16 Amp socket shall be 5/6 pin type (unless otherwise specified) suitable for 16/6 Amp. All modular switches, sockets, telephone outlets, TV outlet etc. shall be in off white finish unless otherwise specified. The switches controlling the lights or fans shall be connected to the phase wire of the circuit. Switch boards shall be located at 1200 mm above finished floor level unless otherwise indicated on drawings or directed by Engineer-In-Charge.

In case of computer power points, Data points, telephone points etc. to be fixed on laminated partition board (furniture), same shall be fixed on laminated board (portion of laminated board meant for fixing power points) with base plate/cover plate as applicable, duly fixed with screws.

One modular switch may control maximum one, two or three light points as per requirement and as directed by Engineer-In-Charge. One light point controlled by 2 switches shall be provided in the starcases as directed by Engineer-In-Charge. Depending on area of rooms, halls etc. one or more than one switchboards shall be provided as directed by Engineer-In-Charge. At least one number 6A Socket with Switch shall be provided in each switchboard as directed by Engineer-In-Charge. Suitable power points and light points shall be provided for urinal sensors and hand dryers in the toilets as directed by Engineer-In-Charge. 10% Light fixtures shall be provided and operated with UPS supply with switches fed from UPS Distribution Boards.

24. COVER PLATE

All modular switches, sockets, telephone outlets etc. shall be fixed on modular metal boxes with modular base plates and modular cover plates on top.

25. WALL SOCKET PLATE

Each outlet shall have a switch located beside the socket preferably on the same cover plate/modular base. The earth terminal of the socket shall be connected to the earth wire.

26. WIRING

All PVC insulated copper conductor wires shall conform to relevant IS Codes. All wires/ cables shall be stranded type irrespective of its size.

All internal wiring shall be carried out with PVC insulated FRLS, Copper wires of 650/1100 Volts grade. The circuit wiring for points shall be carried out in looping in system and no joint shall be allowed in the length of the conductors. Circuit wiring shall be laid in separate conduit originating from...
distribution board to switch board for light/fan. A light/fan switchboard may have more than one circuit but shall have to be of same phase. Looping circuit wiring shall be drawn in same conduit as for point wiring.

Each circuit shall have a separate neutral wire. Neutral looping shall be carried out from point to point or in light/fan switchboards. A separate earth wire shall be provided along with circuit wiring for each circuit. For point wiring red/yellow/blue colour wire shall be used for phase and black colour wire for neutral.

Circuit wiring shall be carried out with red, yellow or blue colour PVC insulated wire for RYB phase wire respectively and black colour PVC insulated Copper wire for the neutral wires. Green/Green-Yellow Colour copper wire shall be used as earth continuity conductor and shall be drawn along with other wires. No wire shall be drawn into any conduit until all work of any nature, that may cause injury to wire is completed. Care shall be taken in pulling the wires so that no damage occurs to the insulation of the wire.

Before the wires are drawn into the conduit, the conduits shall be thoroughly cleaned of moisture, dust and dirt. Drawing and jointing of copper conductor wires and cables shall be as per CPWD specifications for Electrical works (Part - I) 2013

Maximum number of PVC insulated 650/1100 V grade aluminium/copper conductor cable conforming to IS : 694 - 1990

<table>
<thead>
<tr>
<th>Nominal</th>
<th>25mm</th>
<th>32mm</th>
<th>38mm</th>
<th>51mm</th>
<th>64mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross- Sectional area of conductor in Sq.mm.</td>
<td>S</td>
<td>B</td>
<td>S</td>
<td>B</td>
<td>S</td>
</tr>
<tr>
<td>---------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>1.5</td>
<td>10</td>
<td>8</td>
<td>18</td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td>2.5</td>
<td>8</td>
<td>6</td>
<td>12</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>5</td>
<td>10</td>
<td>8</td>
<td>-</td>
</tr>
</tbody>
</table>

Tender No. HITES/IDN/DRUG-LAB/KATHUA/2019-20
NOTE:

- The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.

- The columns headed `S' apply to runs of conduits which have distance not exceeding 4.25m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns headed `B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.

- Conduit sizes are the nominal external diameters.

27. JOINTS.

All joints shall be made at main switches, distribution board socket and switch boxes only. No joint shall be made in conduits and junction boxes. Conductors shall be continuous from outlet to outlet.

28. LOAD BALANCING

Balancing of circuits in three-phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

29. COLOUR CODE FOR CIRCUIT WIRING

Colour code for circuit and sub main wiring installation shall be Red, Yellow, and Blue for three phases. Black for neutral and yellow/green or green only for earth in case of insulated earth wire.

30. CLASSIFICATION OF POINTS.

- General
Classification and measurement of Point wiring shall be as per CPWD specification for Electrical Works (Part-I-Internal) 2013.

- **Point Wiring (Modular)**

  **Definition of Point Wiring:**

  A point (other than socket outlet point) shall include all work necessary in complete wiring to the light points/fan/exhaust fan/call bell point from the controlling switch/MB. The scope of wiring for a point shall, however, include the wiring work necessary in tapping from another point in the same distribution circuit i.e. from first switch board (wiring from distribution board to first switch box is covered in the circuit wiring and is not in the scope of point wiring) to subsequent switch board(s) in the same distribution circuit. The point wiring includes all materials specified below including chasing the wall (in case of recessed wiring in wall), fixing the conduit and making the wall good as it originally was. It also includes supply, drawing, testing and commissioning of wires.

- **Scope of point wiring**

  Following shall be deemed to be included in point wiring.

  a. Supply & fixing conduit & conduit accessories for the same and wiring cables (including supplying and drawing wires) between the switch box and the point outlet.

  b. All fixing accessories such as clips, nails, screws, phil plug, rawl plug etc. as required.

  c. Modular switches, modular base plates and modular cover plates over the same, regulators, sockets with Metal boxes etc. in recessed or surface.

  d. Outlet boxes, junction boxes, pull-through boxes etc. but excluding modular metal boxes if any, provided the switchboards for loose wires/conduit terminations.

  e. In case of recessed wiring in wall the scope includes chasing of wall, fixing the conduit and making the wall good as it originally was.

  f. Control modular switch (5/6A) as specified.

  g. Ceiling rose or connector (in case of points for ceiling/exhaust fan point, prewired light fittings and call bells).

  h. Connections to ceiling rose, connector, socket outlet, lamp holder, switch etc.
i. Interconnecting wiring between points on the same circuit, in the same switch box or from another. Interconnecting wiring from first switchboard to subsequent switch board(s).

j. Protective (loop earthing) conductor as required from one metallic switch box to another in the distribution circuits, and from switchboard to each point (light/fan/exhaust fan/call bell etc).

k. Bushed conduit where wiring cables pass through wall etc.

l. Ceiling rose (in the case of pendants except stiff pendants).

m. Lamp holder (in the case of goose neck type wall bracket, batten holder and fittings which are not pre-wired).

n. Back Plate (in the case of stiff pendants).

31. Circuit and Submain Wiring

- Circuit Wiring

Circuit wiring shall mean the wiring from the distribution board up to the tapping point for the nearest first point of that distribution circuit i.e. up to the nearest first switch box.

- Submain Wiring

Submain wiring shall mean the wiring from one main/distribution switchboard to another.

32. Power Plug Wiring

6A Plug Wiring

Wiring for all 6 A Socket Outlets shall be done with 2 X 2.5 sqmm PVC insulated copper wire in suitable size MS Conduit (including supplying and fixing MS Conduit) along with the earth wire. Up to 3 points may be connected to one circuit.

16A Power Plug Wiring

Wiring for all 16 A Socket Outlets/Geyser point shall be done with 2X4 sq mm PVC insulated copper wire in suitable size MS Conduit (including supplying and fixing MS Conduit) along with the earth wire, directly from the MCB- Distribution Board or from one power socket outlet to another in case of computer power points. Looping shall not be done in general 16A power points (other than computer power points).
Wiring for 20A Metal Clad Socket Outlets

Wiring for all 20A Metal Clad Socket Outlets shall be done with 2X6 sqmm PVC insulated copper wire in suitable size MS Conduit (including supplying and fixing MS Conduit) along with the earth wire directly from the MCB-Distribution Board. Measurement of wiring for 20A Metal Clad Socket outlet shall be done on linear basis i.e. complete wiring directly from MCB-Distribution Board to the socket outlet.

33. CONDUCTOR SIZE.

Wiring shall be carried out with following sizes of PVC insulated stranded single core copper conductor wire/cable.

i. Light Point - 1.5 sq.mm
ii. Ceiling /Cabin/Exhaust Fan Point - 1.5 sq.mm
iii. Call Bell Point - 1.5 sq.mm
iv. 6A Plug Point/ UPS Computer outlets (up to 3 outlets on one ckt.) - 2.5 sq.mm
v. Circuit Wiring - 2.5 sq.mm
vi. General Power Point – 4 sq.mm
vii 20A Industrial Socket Outlet – 6 Sqmm
viii Special Power Point – 6 Sqmm
ix A/C Box with 32 A MCB - 6 Sqmm

34. LIGHTING FIXTURE AND FANS

35. GENERAL

a. The Contractor shall supply and install all LED Lighting fixtures as per IS 4347 for Hospital Lighting.

b. All fixtures shall be delivered to the building complete with suspension accessories, canopies, hanging devices, sockets, holders, reflectors, balls, diffusing material, louvers, plaster frames, recessing boxes, etc. all wired and assembled as indicated.
c. Full size shop detail drawings of special fixture or lighting equipment, where called for in the fixtures, shall be submitted to the Engineer In Charge for approval.

d. Fixtures, housing, frame or canopy, shall provide a suitable cover for fixture outlet box or fixture opening.

e. Fixtures shall comply with all applicable requirements as herein outlined unless otherwise specified or shown on the Drawings.

f. Manufacturer’s name and catalogue number of light fixtures, fans, switchgears etc. shall be strictly adhered.

g. Fixtures shall bear manufacturer’s name and the factory inspection label.

h. Fixtures shall be completely wired and constructed to comply with the IEE wiring regulations requirements for lighting fixtures, unless otherwise specified.

i. Revamping the fixture shall be possible without having to remove the fixture from its place.

j. Lamps of the proper type, wattage and voltage rating shall be furnished and installed in each fixture.

k. For Labs, ICU, CCU and other Critical Areas, Clean Room LED Light Fixtures shall be provided to maintain requisite Lux level as per NBC 2016, ECBC and as directed by Engineer-In-Charge.

36. INSTALLATION

Fixtures shall be installed at mounting heights as detailed on the Drawings or as instructed on site by the Engineer-In-Charge.

Pendent fixtures within the same room or area shall be installed plumb and at a uniform height from the finished floor. Adjustment of height shall be made during installation.

Flush mounted recessed fixtures, shall be installed so as to completely eliminate leakage of light within the fixture and between the fixture and adjacent finish.

Fixtures mounted outlet boxes shall be rigidly secured to a fixture stud in the outlet box. Hickeys or extension pieces shall be installed where required to facilitate proper installation.

Fixtures located on the exterior of the building shall be installed with non-ferrous metal screws finished to match the fixtures.
37. LED Light Fixtures -GENERAL

LED Lighting fixtures shall provide luminous efficacy of more than 110 Lumens/ Watt, including Driver & accessories. LED Light Fixtures shall have inbuilt harmonic mechanism to mitigate harmonics.

38. BALLASTS/ Driver

Ballasts / Driver shall be electronic type and having high power factor type.

Ballasts shall have manufacturer's lowest sound level and case temperature rise rating.

39. TESTING

After all lighting fixtures are installed and are connected their respective switches, test all fixtures to ensure operation on their correct switch in the presence of the engineer.

All non-operating fixtures or ones connected to the wrong or inconveniently located switch shall be correctly connected as directed by the Engineer In-charge. Stickers are to be placed on each light fixture w.r.t. controlling switch of respective light.

40. CEILING FANS

All ceiling fans shall be provided with suspension arrangement in the concrete/slab/roof members. Contractor to ensure that provision are kept at appropriate stage at locations shown on the drawing. Fan box with MS hook shall be as per CPWD specification. Ceiling fan shall be Heavy Duty, double ball bearing type, copper wound motor complete with canopy, down rod, blades etc. and shall conform to relevant IS Standards. Ceiling Fans shall be white in colour. Ceiling fan shall be provided with electronic regulator. Electronic Regulator shall be suitable for 240 volts A.C supply 50 Hz and shall be of continuous duty type and with BEE Star rating. Ceiling Fans shall be 5-Star BEE rated & comply to ECBC norms.

41. EXHAUST FANS

Exhaust fans shall be heavy-duty type with double ball bearing and conforming to IS 2312 (latest revision). Exhaust fan shall be complete with
copper wound motor, capacitor, Louver/shutter, frame and mounting bracket. Exhaust fan shall be suitable for operation on 240 volts single phase A.C supply with BEE 5-star rating & comply to ECBC norms.

42. DISTRIBUTION BOARDS & MCBs

43. General

44. DISTRIBUTION BOARDS

As a general practice MCB type double door DB shall be used. Provision of Vertical type MCB DBs is to be considered in areas where 3-phase outlets are also required:

Provisions in MCB DB:

i) Recess/ surface type with integral loose wire box.

ii) Phase/neutral/ earth terminal blocks for termination of incoming & outgoing wires.

iii) DIN channel for mounting MCBs.

iv) Arrangement for mounting incomer MCB/RCCB/RCBO/MCCB as required.

v) Copper Bus Bar.

vi) Earthing terminals.

vii) Interconnection between terminal block/ incoming switch/ bus bar/ neutral/ terminal block/ earth terminal connector with specified size of FRLS pre insulated copper conductor cable duly fitted with copper lugs/thimbles.

ix) Termination block should be suitable for termination of conductor/ cable of required size but minimum rated cross section of the terminal blocks should be 6 sq. mm.

x) Terminal block shall be made of flame retardant polyamide material.

xi) Coloured terminal blocks and FRLS wires for easy identification of RYB phases, Neutral and Earth.

xii) DB shall be provided with a detachable cassette for safe removal of MCBs, RCCBs. Terminal connectors from the DB without loosening the internal cable connections of phase and neutral circuits.

xiii) The DB shall have peel able poly layer on the cover for protection from
cement, plaster, paints etc during the construction period.

xiv) Detachable plate with knock out holes shall be provided at the top/ bottom of board. Complete board shall be factory fabricated and pre-wired in factory, ready for installation at site. The box and cover shall be fabricated from 1.6 mm sheet steel, properly pretreated, phosphotized with powder coated finish.

xv) DB shall be of double door construction provided with hinged cover in the front.

xvi) DB doors shall be suitably earthed.

Distribution Board shall be standard type. Distribution boards shall contain miniature circuit breakers. Miniature circuit breakers shall be quick make and quick break type with trip free mechanism. MCB shall have thermal and magnetic short circuit protection. All miniature circuit breakers shall be of minimum 10 kA rated rupturing capacity unless otherwise specified.

Neutral busbars shall be provided with the same number of terminals, as there are single ways on the board, in addition to the terminals for incoming mains. An earth bar of similar size as the neutral bar shall also be provided. All live parts shall be screened from the front. Ample clearance shall be provided between all live metal and the earth case and adequate space for all incoming and outgoing cables. A circuit identification card in clear plastic cover shall be provided for each distribution board.

MCB’s shall be provided on the phase of each circuit. The individual banks of MCB's shall be detachable. There shall be ample space behind the banks of MCB's to accommodate all the wiring. All the distribution boards shall be completely factory wired, ready for connections. All the terminals shall have adequate current rating and size to suit individual feeder requirements. Each circuit shall be clearly numbered from left to right to correspond with wiring diagram. All the switches and circuits shall be distinctly marked with a small description of the service installed.

Earth Leakage Circuit Breaker/Residual Current Circuit Breaker shall be provided in each Distribution Board as required. Earth Leakage Circuit Breaker shall be current operated type and of 30 mA sensitivity unless otherwise specified. It shall also provide over-current and short circuit protection i.e. it shall be MCB-cum-RCCB (Residual Current Circuit Breaker). In case ELCB doesn't have inbuilt short circuit protection, same rating MCB have to be provided for short circuit protection along with ELCB. Cost of this MCB is deemed to be included in the cost of ELCB. ELCB shall be housed within the Distribution Board.

Distribution Boards shall be ready for connections and shall be inspected in the factory by Electrical Engineer In charge before dispatch.

Before procurement of Distribution Boards, MCB's, ELCB's (incomer and outgoings) etc., the contractor has to take approval of the DB Schedule/Drawings of each DB from the Electrical Engineer In Charge. The whole unit i.e.
Distribution Board, MCB’s, ELCB’s etc. shall come from the manufacturer's premises/workshop. After inspection and clearance from the HITES Electrical Engineer the same may be dispatched to site for installation. However if a single component (such as ELCB or MCB or DB) is required for any reason such as replacement, increase in no. of circuits in the DB, change in the load of existing circuit, change in the total load on a particular DB etc., the same may be ordered separately.

45. TELEPHONE SYSTEM

- **Point Wiring for Telephone System**

  a) The point wiring shall be carried out with telephones wires/cables, 2 pair, un-armoured, PVC insulated and sheath, 0.51 mm dia annealed tinned copper conductor, conforming to ITD specification S/WS-113C armouring and outer sheath as per IS: 1554 (Part -I) in 25 mm steel conduit (one pair always remaining spare for one point). If more than one telephone point has to be provided at one point, multi-core, un-armoured telephone cable shall be used (pairs required are equal to 2 x no. of points) in suitable size conduit. If specifically mentioned in schedule of quantities, instead of ordinary PVC insulated telephone wire as specified above, UTP cable Cat – 6 to be supplied & laid.

  b) The item includes providing and fixing/laying of conduit, switch boxes, socket for telephones connection and telephone wires/cables etc.

  c) Minimum diameter of steel conduit for telephone wiring shall be 25 mm.

  d) The point shall commence from the main telephone tag box/sub tag box and would terminate at outlet box of point. Connection at both ends included in point wiring.

  e) Steel conduit, accessories, draw out boxes, switch boxes etc. shall be supplied & laid as per the details given at 2.0.

  f) Each telephone point shall have 1 no. flush type RJ11 telephone jack fixed on 3 mm thick, hylem sheet in MS outlet box (size 100 x 100 mm). More than one telephone socket outlet (maximum 2 nos.) can be fixed on one outlet box, provided these points are at one place and multi-pair (more than 2 pair) telephone cable has been drawn to this point from tag box. However if specified in schedule of quantities, telephone cord grid plate mounted outlet unit (RJ – 11) with moulded cover plate in recessed galvanized MS box to be provided.

  g) Joint in telephone wiring (between main tag box/sub tag box and outlet box of point) shall not be allowed and the contractor should bear the wastage of wire if resulted due to this special requirement of telephone system. No looping in telephone system is allowed unless specifically shown in the drawing or instructed by site engineer in the drawing/instruction book.
h) Telephone and computer data wiring can be drawn in the same conduit, provided after drawing wires, 50% of conduit cross sectional area is free. However independent PVC insulated telephone & data wire of suitable size shall be used for telephone and computer data.

i) To identify each pair of multi-pair telephone wire/cable, PVC indication numbers shall be put on both end of pair just before termination.

- **Point Wiring (Computer Data)**

  a) The point wiring shall be carried out with data cable of 4 (FOUR) pairs (or as specified in schedule of quantities) un-armoured, PVC insulated and sheath, 0.50 mm dia annealed tinned copper conductor (CAT 5e or CAT 6 as specified in schedule of quantities), in suitable size conduit.

  b) The item includes providing and fixing/laying of conduit, switch boxes, socket for computer connection and data wires/cables etc

- **Minimum diameter of steel conduit for telephone wiring shall be 25 mm.**

  a) The point shall commence from the main junction box or sub junction box at floor of computer data system, and would terminate at outlet box of point. Connection at both ends of cable shall be carried out by purchaser.

  b) General specification for concealed/surface conduit system of telephone system (clause no. 5.1 (c), 5.1 (d) & 5.1 (g) shall be applicable for this system also.

  c) Joint in computer data cable (between junction box and outlet box of point) shall not be allowed and the contractor should bear the wastage of cable if resulted due to this special requirement of computer data system.

- **Telephone Cable Work (Underground System)**

  a) The cable shall be suitable for telephone system of suitable pairs (as specified in schedule of quantities), steel armoured, PVC insulated and sheath, 0.51 mm dia annealed tinned copper conductor, conforming to ITD specification S/WS-113C armouring and outer sheath as per IS:1554 (Part-I). All telephone cables for underground laying shall be jelly filled type.

  b) Specification for laying of telephone cable in underground system shall be same as for electrical system (clause no. 4.2,4.3,4.4 and 4.5 and the same shall be followed.

- **Telephone Tag Boxes**

  a) These shall be of KRONE type using insulation displacement technique in which there is no stripping or soldering of wire, of MS sheet 14 G with connector suitable for telephone connection. It shall have hinged MS sheet
cover. Tag box to be of sufficient size to not only accommodate required KRONES but also space for dressing of wires.

- **Television Point Wiring**

  a) only steel conduit minimum 25mm dia shall be provided and laid for all tv wiring. All specifications for conduting shall be same as mentioned above.

  b) Co-axial TV cable of single strand tinned copper conductor of diameter 0.80 mm, complete with metallic shield. Cable having signal loss less than 6 db per 100 Mts. for band 1 UHF should be provided and laid.

  c) One number TV wall outlet in suitable MS box should be fixed at each receiving end.

  d) In each 25 mm dia conduit max. 2 nos. co-axial cables should be drawn. There should be the least possible number of bends in the conduit system.

  e) The samples of TV cable & wall outlet should be got approved before installing.

  f) Matter to be checked by contractor with purchaser, whether system of each TV point having its own TV antenna is there for the project or cable TV system having common antenna for project is to be followed. This shall be specially applicable if in the project residential quarters are also included. If central cable TV system is their, necessary amplifier, tap-off, and splitters etc. to be provided as per detail drawings and schedule of quantities.

- **Enhanced Category 6 UTP specifications**

  a) The UTP shall be 4-pair, with 24 SWG solid or standard copper conductors.

  b) The UTP-based cabling system shall have a 160 MHz channel channel bandwidth over a maximum distance of 100m (328 ft) and a channel power sum attenuation-to-crosstalk ratio (PSACR) of 9.6 dB@ 100 MHz using an interconnect or BIX cross connect configuration.

  c) The UTP-based cabling system shall use matched components from a single manufacturer, certified to deliver system performance over the lifetime of the application that the cabling system was originally designed to support.

  d) The UTP-based cabling system shall comply with the following standards:

    Enhanced Category 5 – TIA/EIA Addendum

    Category 5 – ANSI/TIA/EIA-568, TIA/EIA TSB67

    Class D – CENELEC EN50173

    Class D – ISO/IEC 11801
• **UTP Outlets**

  a) The outlet UTP connection module and its optional cover shall be available in the following colors: grey, almond, white, black, orange, red, yellow, green, blue, purple and brown.

  b) The outlet UTP connection module shall be Power Sum rated, with a power Sum NEXT performance equal to or better than ANSI/TIA/EIA-568 Category 5 pair-to-pair NEXT performance specifications, and shall have a PS5 marking to indicate compliance.

  c) The eight-position outlet UTP connection module shall accommodation six-position modular plug cords without damage to either the cord or the module.

  d) It shall be possible to inspect and/or re-terminate the UTP cable at the outlet through front access at the face plate.

  e) The faceplate housing the outlet UTP connection modules shall have aperture plugs to cover any unused openings in the faceplate.

  f) The faceplate housing the outlet UTP connection module in wall mounted single and dual-gang electrical boxes, utility poles and modular furniture (cubical) access points using manufacturer – supplied faceplates and/or adapters, equipped with front, side or angled-entry options for modular cords.

• **UTP System Testing**

  - There are two primary field test parameters for an UTP-based end-to-end cabling system. These are continuity/wire mapping and a visual inspection, both to be performed by the vendor.

  - Continuity/wire mapping is used to verify consistency pair-to-pin terminations at each end of a given cable. It also checks for faulty connections in the run. For each of the eight conductors in the cable, continuity/wire mapping indicates:

    - Continuity of the channel to the remote end.
    - Shorts between any two or more conductors.
    - Crossed pairs.
    - Reversed pairs.
    - Split pairs.
    - Any other wiring.

  - LAN wiring shall be done with Category 6 (CAT 6) wire, if specifically asked for in BOQ.
TELEPHONE TAG BLOCK (TTB / IDF)

CAT-6 (enhanced) unshielded twisted pair cable in MS conduit shall be used to have modern structured cabling network for telephone system, to have latest facilities for Internet and also data cabling. All the telephone Jack must terminated on RJ-11 jacks and installed onto a dual Jack faceplate. Telephone RJ-11 Jacks must be terminated with a BLACK Connector/Jack.

For LAN CAT 6 UTP cables shall be used for interconnecting the RJ 45 outlets to Intermediate Switch (Hub) or directly to IT room, if the running length limit permits. These intermediate switch shall be installed in a rack/cabinet and located in electrical room of the respective floors. Fibre Optic cable or CAT-6 UTP cable shall be used for backbone to interconnect the Intermediate switch to IT room’s Server rack, as per the design requirement of the specialised Vendor. All the Data Jack must terminated on an 8 wire, 8-position Jack. Each RJ-45 Data Connection will be terminated with a BLUE Data Jack.

Only conduit routing & wiring shall be provided by the Electrical contractor and the configuration & wiring shall be done by the Vendor for the IT Networking.

EPABX system, with latest technology will be provided to provide Voice Mail & Call Accounting by costing of all calls made by telephones.

A small cabinet for Low current services shall be provided at the false ceiling level to locate all the terminal points like Tel.Tag block, tap-off box for MATV etc., for interconnecting all the low current outlets (jacks). Each tel. outlet shall be provided a separate wire from the room tag block.

Similarly one CAT-5e wire from the floor TTB/IDF shall be provided for each Tel. Outlet proposed.

A Multi pair box Tel. Cable shall be laid from the Service gate to the Telephone switch room MDF for Direct lines from the Service provider. Some of the lines shall be bypassed to EPABX and shall be directly provided to Top management’s office & Telephone operators for direct communication to outside. Rest of the lines shall be routed through EPABX for the use of patrons & staff through extensions. The following area/desk shall have direct access to outside Tel. lines:

a) Telephone Operator’s room
b) Telephone Switch room
c) Security room
d) Fire officer room

46. LAN NETWORKING SPECIFICATIONS
47. General:

RJ 45 data outlets are proposed to be provided for Computers, networking as per requirement in rooms and other areas at various floors in all the blocks / buildings.

The Data Outlet points shall be connected to Rack Panel/Computer hub with 4 pair Cat-6 wiring in recessed conduit / Raceways.

The maximum Length of the Cat 6 cable from end user point to the Hub or Edge switches shall not be more than 90Mtr. Beyond this length Fiber Optic Cable shall be used. UPS Power supply to these computers will also run through conduits/ floor trunking.

The Rack Panel/computer hub at various floors will be connected to Main rack of the building/ block with fiber optic cable through conduit or raceways on surface/in recess.

Brick masonry manholes with covers shall be provided at suitable lengths to facilitate easy wire pulling & Maintenance.

The LAN SYSTEM comprises of Passive components and Active Components. The Technical specifications of both the components are given below:

48. PASSIVE (STRUCTURED CABLING)

1. 2 & 4 Port Shuttered Face Plate

<table>
<thead>
<tr>
<th>Standard Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shall be available in 2 port and 4 port square versions.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>General Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Color: White</td>
</tr>
<tr>
<td>b) Width: 86.36 mm (3.4 in)</td>
</tr>
<tr>
<td>c) Height: 86.36 mm (3.4 in)</td>
</tr>
<tr>
<td>d) Depth: 13.72 mm (0.54 in)</td>
</tr>
</tbody>
</table>

| Material shall be high impact, flame retardant, UL-rated 94 V-0, thermoplastic. |
| Flammability Rating: UL 94 V-0 |
| Safety Standard: UL Listed |
| Shall be compatible with CAT 5e/CAT 6/CAT 6A information outlets. |
Shall have inbuilt shutters to prevent dust to accumulate on the information outlets which are not in use.

2. **6/12 CORES INDOOR MM OM3 FIBER CABLE**

<table>
<thead>
<tr>
<th><strong>Standard Compliance</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Shall be Multimode (OM3), Low Smoke Zero Halogen Riser Distribution Cable, 6/12 fiber single-unit.</td>
</tr>
<tr>
<td>Qualification Standards: ANSI/ICEA S-83-596 and Telcordia GR-409</td>
</tr>
<tr>
<td>Standards Compliance: TIA-492AAAC (OM3), Bend-Insensitive Multimode Fiber</td>
</tr>
<tr>
<td>Flame Test Method: IEC 60332-3, IEC 60754-2, IEC 61034-2, IEEE 383, UL 1666 and UL 1685</td>
</tr>
<tr>
<td>Regulatory Compliance: RoHS 2011/65/EU compliant</td>
</tr>
<tr>
<td>No. of Fibers: 6/12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Construction Materials</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Jacket Material: LSZH</td>
</tr>
<tr>
<td>b) Jacket Color: Aqua</td>
</tr>
<tr>
<td>c) Subunit Type: Gel-free</td>
</tr>
<tr>
<td>d) Non Armored: Yes</td>
</tr>
<tr>
<td>e) Core/Cladding/buffer diameter: 50 / 125 / 900 µm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Dimensions</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Cable Diameter: 6.07 mm (0.24 in)</td>
</tr>
<tr>
<td>b) Cable Weight: 34 kg/km</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Physical Specifications</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Minimum Bend Radius, loaded: 9.1 cm</td>
</tr>
<tr>
<td>b) Minimum Bend Radius, unloaded: 6.1 cm</td>
</tr>
<tr>
<td>c) Tensile Load, long term, Max: 200 N</td>
</tr>
<tr>
<td>d) Tensile Load, short term, Max: 667 N</td>
</tr>
<tr>
<td>e) Vertical Rise, Max: 500 m</td>
</tr>
</tbody>
</table>
## Environmental Specifications

<table>
<thead>
<tr>
<th>Environmental Space: Low Smoke Zero Halogen (LSZH) and Riser</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation Temperature: -30 degree Celsius to +60 degree Celsius</td>
</tr>
<tr>
<td>Operating Temperature: -40 degree Celsius to +70 degree Celsius</td>
</tr>
<tr>
<td>Storage Temperature: -40 degree Celsius to +70 degree Celsius</td>
</tr>
</tbody>
</table>

## Mechanical Test Specifications

<table>
<thead>
<tr>
<th>Compression: 10 N/mm (as per IEC 60794-1 E3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flex: 100 Cycles (as per IEC 60794-1 E6)</td>
</tr>
<tr>
<td>Impact: 5.88 N-m (as per IEC 60794-1 E4)</td>
</tr>
</tbody>
</table>

## Optical Specifications

### Attenuation, Maximum

<table>
<thead>
<tr>
<th>1.00 dB/km @ 1300 nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.00 dB/km @ 850 nm</td>
</tr>
</tbody>
</table>

### Index of Refraction

<table>
<thead>
<tr>
<th>1.479 @ 1300 nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.483 @ 850 nm</td>
</tr>
</tbody>
</table>

### 1 Gbps Ethernet Distance

<table>
<thead>
<tr>
<th>600 m @ 1300 nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1020 m @ 850 nm</td>
</tr>
</tbody>
</table>

### 10 Gbps Ethernet Distance

| 300 m @ 850 nm |

### Bandwidth, Laser, Min.

<table>
<thead>
<tr>
<th>500 MHz-km @ 1300 nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000 MHz-km @ 850 nm</td>
</tr>
</tbody>
</table>

### Bandwidth, OFL, min.
a) 500 MHz-km @ 1300 nm  
b) 1500 MHz-km @ 850 nm

3. **Fiber Optic LC style OM3 Cassettes**

   **Standard Compliance**

   - Shall have provision to terminate 12 Fibers
   - Shall have Aqua color adapters with LC interface.
   - Shall be intelligent ready cassettes
   - The adaptor plate shall be RoHS compliant

4. **Fibre Optic LC style OM3 pigtail for Cassettes**

   **Standard Compliance**

   **Minimum Specifications**

   - Each pigtail shall have attenuation less than 0.3 dB
   - Each Pigtail shall be made of LSZH material
   - Each pigtail shall have a return loss of 30 dB or better
   - Each pigtail shall be RoHS compliant


   **Standard Compliance**

   **Minimum Specifications**

   - Length shall be 3/5/10 meters
   - All patch cords shall conform to EIA/TIA-568C.3 and ISO/IEC-11801
   - Shall be Duplex Multi Mode Fiber Optic Patch Cords OM3 50μ
   - Shall support network line speeds up to 10 Gbps.
   - Each patch cord shall have a LC connector on both sides or SC LC as per requirement
   - All patch cords shall be factory terminated and packed.
Shall be RoHS Compliant

Shall be Low-Smoke & Zero-Halogen

Shall have minimum 20-Year Extended Product Warranty

### 6. 12 CORES - OUTSIDE PLANT FIBER CABLE

**Standard Compliance**

- Shall be Singlemode (OS2), Single Jacket, Single Armor, Gel-free, Zero Water Peak Fiber.

- Qualification Standards: ANSI/ICEA S-87-640, EN 187105 and Telcordia GR-20


- Regulatory Compliance: RoHS 2011/65/EU compliant

<table>
<thead>
<tr>
<th>No. of Fibers</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Tubes</td>
<td>1</td>
</tr>
</tbody>
</table>

**Construction Materials**

- **a)** Jacket Material: MDPE
- **b)** Armor Type: Corrugated Steel
- **c)** Number of fibers per tube: 12
- **d)** Filler Quantity: 4
- **e)** Jacket Color: Black
- **f)** Jacket UV Resistance: UV Stabilized
- **g)** Subunit Type: Gel-free
- **h)** No. of Rip cords: 2
- **i)** Water Swellable Tape: Yes

**Dimensions**

- **a)** Cable Diameter: 11.50 mm (0.45 in)
- **b)** Cable Weight: 108 kg/km
### Physical Specifications

<table>
<thead>
<tr>
<th></th>
<th>Minimum Bend Radius, loaded: 17.3 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Minimum Bend Radius, unloaded: 11.5 cm</td>
</tr>
<tr>
<td>b)</td>
<td>Tensile Load, long term, Max: 800 N</td>
</tr>
<tr>
<td>c)</td>
<td>Tensile Load, short term, Max: 2700 N</td>
</tr>
</tbody>
</table>

### Environmental Specifications

<table>
<thead>
<tr>
<th></th>
<th>Environmental Space: Aerial, lashed or Buried</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Installation Temperature: -30 degree Celsius to +70 degree Celsius</td>
</tr>
<tr>
<td>b)</td>
<td>Operating Temperature: -40 degree Celsius to +70 degree Celsius</td>
</tr>
<tr>
<td>c)</td>
<td>Storage Temperature: -40 degree Celsius to +75 degree Celsius</td>
</tr>
</tbody>
</table>

### Mechanical Test Specifications

<table>
<thead>
<tr>
<th></th>
<th>Compression: 44 N/mm (as per IEC 60794-1 E3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Flex: 35 Cycles (as per IEC 60794-1 E6)</td>
</tr>
<tr>
<td>b)</td>
<td>Impact: 2.94 N-m (as per IEC 60794-1 E4)</td>
</tr>
<tr>
<td>c)</td>
<td>Water Penetration Test Method: 24 h (as per IEC 60794-1 F5)</td>
</tr>
</tbody>
</table>

### Optical Specifications

#### Attenuation, Maximum

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>0.22 dB/km @ 1550 nm</td>
</tr>
<tr>
<td>b)</td>
<td>0.27 dB/km @ 1490 nm</td>
</tr>
<tr>
<td>c)</td>
<td>0.31 dB/km @ 1385 nm</td>
</tr>
<tr>
<td>d)</td>
<td>0.34 dB/km @ 1310 nm</td>
</tr>
</tbody>
</table>

#### Index of Refraction

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>1.467 @ 1310 nm</td>
</tr>
<tr>
<td>b)</td>
<td>1.468 @ 1385 nm</td>
</tr>
<tr>
<td>c)</td>
<td>1.468 @ 1550 nm</td>
</tr>
</tbody>
</table>
Cabled Cutoff Wavelength, maximum: 1260 nm

### 7. 48/24/12 Sliding Fiber Shelf – For Single Mode & Multimode Fiber

#### Standard Compliance

- Shall accommodate 4 coupler plates or 4 pigtail cassettes for a total of 48 fiber terminations.
- The width shall be 19 inches and height of 1U (1.75 inches), with a maximum of 18 inch depth.
- The shelf/LIU shall be sliding.
- The Fiber shelf must be intelligent ready and must support field upgrade to intelligent fiber panels without removal of existing patch cords and without disruption of network services.
- Shall have splice trays to splice minimum 32 fibers.

### 8. 12 Fiber Single mode Fiber Pigtail Cassettes

#### Standard Compliance

- Shall be Single mode OS2, zero water peak fiber.
- Regulatory Compliance: RoHS 2011/65/EU
- Safety Standard: UL
- Number of Fiber: 12
- Interface, Front: LC
- Adapter Color: Blue

#### Optical Performance

a) Insertion Loss Change, mating: 0.30 dB  
b) Insertion Loss Change, temperature: 0.30 dB  
c) Insertion Loss, Typical: 0.30 dB  
d) Return Loss, Min: 55.0 dB

#### Pigtail Environmental Specifications
<table>
<thead>
<tr>
<th>Environmental Space: Plenum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Temperature: -10 degree Celsius to +60 degree Celsius</td>
</tr>
<tr>
<td>Cable Retention Strength, Max: 1.00 lb @ 0 degree, 1.00 lb @ 90 degree</td>
</tr>
<tr>
<td>Ferrule Geometry: Pre-radiused</td>
</tr>
<tr>
<td>Ferrule Material: Zirconia</td>
</tr>
<tr>
<td>Optical Components Standard: ANSI/TIA-568-C.3</td>
</tr>
</tbody>
</table>

9. **LC – LC Single mode LSZH Patch Cords**

<table>
<thead>
<tr>
<th>Standard Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shall be Single mode (OS2), zero water peak, LC to LC, Fiber patch cords.</td>
</tr>
<tr>
<td>Regulatory Compliance: RoHS 2011/65/EU</td>
</tr>
<tr>
<td>Jacket: Low Smoke Zero Halogen (LSZH) compliant to IEC 60332-3, IEC 60754-2, IEC 61034-2, IEEE 383, UL 1666, UL 1685</td>
</tr>
<tr>
<td>Flame Test Listing: NEC OFNR-LS (ETL) and c(ETL)</td>
</tr>
<tr>
<td>Cable Qualification Standards: ANSI/ICEA S-83-596 and Telcordia GR-409</td>
</tr>
<tr>
<td>Optical Components Standard: ANSI/TIA-568-C.3</td>
</tr>
</tbody>
</table>

**General Specifications**

<table>
<thead>
<tr>
<th>Connector Color: Blue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connector Interface: LC</td>
</tr>
<tr>
<td>Operating Temperature: -10 degree Celsius to +60 degree Celsius</td>
</tr>
</tbody>
</table>

**Connector Optical Performance**

<table>
<thead>
<tr>
<th>Insertion Loss, Typical: 0.20 dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return Loss, minimum: 55.0 dB</td>
</tr>
<tr>
<td>Insertion Loss Change, mating: 0.30 dB</td>
</tr>
<tr>
<td>Insertion Loss Change, temperature: 0.30 dB</td>
</tr>
</tbody>
</table>

10. **24/48 Fiber Joint Enclosure (IP 68 Rated)**
**Standard Compliance**

Shall be a butt type enclosure with a dome and base

The cable entries should be through the cable ports located in the base.

The dome and base should be sealed using a clamp with O-ring system. The cable entry ports should be sealed mechanically and using gel sealing technology instead of heat shrink.

**General Specifications**

a) IP68 Rated

b) No. of Splice trays: 6 nos.

c) Splice Tray Capacity: 24 Fibers

d) No. of cable entry ports: 4 round ports and 1 oval port.

The mechanical sealing unit should have a rotary mechanism which can be used for sealing, no special tools should be used for sealing.

The block should be opened and closed repeatedly without removing or replacing the Gel.

The closure should have the capability to accommodate loop cables (un cut loose tube cables).

The cables should be secured to the closure using hose clamps and a cable attachment device.

The closure should have a basket for storing loose tubes.

The dome should have pressure valve.

11. **Single Side 1U Cable Manager**

**Standard Compliance**

Shall be a single sided 1U, 19 Inch Cable Manager

Safety Standard: UL

Regulatory Compliance: RoHS 2011/65/EU

Material Type: Aluminium and Steel

**General Specifications**
a) Color: Black

b) Rack Units: 1

c) Finish: Powder coated, smooth

Shall have fingers to maintain the patch cord bend radius

The front shall have a hinged door for easy access

12. Specification for CAT 6 LSZH U/UTP Cable

**Standard Compliance**

The Category 6/Class E UTP system shall comply with the following standards

- ISO/IEC 11801
- EN 50173 Part 1 through Part 5: 2010 and 2011
- ANSI/ TIA 568C.2
- IEC 60603-7-4
- IEEE 802.3 applications

The Category 6/Class E UTP system should support the following IEEE Ethernet applications

- 802.3e - 1BASE5
- 802.3i - 10BASE-T
- 802.3u - 100BASE-TX, 100BASE-T4
- 802.3y - 100BASE-T2
- 802.3z - 1000BASE-X
- 8023ab - 1000BASE-T
- 802.af - Power Over Ethernet (15.4W)
- 802.3at - Power Over Ethernet Enhancements (25.5W)
- 802.3az - Energy Efficient Ethernet

Channel Performance
It is critical that guaranteed worst-case values are provided to ensure the SCS can support 1G transmission without risk. “Average value” or “Typical Value” is not acceptable as they do not account for lower performance channels. The proposed Category 6 UTP SCS, when configured as a worst-case 100 metre channel shall provide performance headroom over limits specified by Cat6

The SCS must consist of individual components provided by the same manufacturer. “Mix and Match” products are not allowed as there is no guarantee that the overall channel will meet Category 6 Channel requirements if constructed with components from different vendors.

The Category 6 cable and Category 6 channel components shall be manufactured by a single manufacturer. The manufacturer shall warrant the Category 6 channel cable, components, and applications for a period of 20 years.

Should support a minimum of 4 connector Channel with a minimum 6 dB guaranteed NEXT over and above the standard TIA 568 C.2

Should support 6 connector Channel with a minimum 4 dB guaranteed NEXT

The Delay Skew on the 100 meter channel shall not exceed 30 ns

The SCS must be tested by an ISP 17025 accredited 3rd Party test facility to EIA/TIA 568C, ISO/IEC 11801 and for the channel

SCS must support patch cord lengths of 1 meter minimum and equipment cords of 1 meter minimum

The Category 6 system should support channels that are shorter than 15 meters for 2,3,4 connector channels without any minimum length requirements.

Should support 117 meters with a 4 connector channel design for IEEE 802.3ab 1000BASE-T

Horizontal Cable

The Cable should meet ANSI/TIA 568C.2 Category 6 Specifications

Cables should have TRACKING Number to check the genuity / details of the test reports

The cable should consist of Eight 23 AWG copper conductors. Copper Clad Aluminium or any other combinations are not allowed

The weight of the cable box of 1000 Feet should not be less than 25.6 lbs

The nominal Jacket thickness should be 0.022 inches
The nominal Outside diameter should be 0.232 inches

The cable should support the installation temperature: 0 to 60°C

It should support Operating temperature of -20 to 60°C

Should have ETL verified CMR, CMG

The LSZH Cable should support the following standard to qualify

ISO/IEC 60332-3-22 Vertical Flame spread test

ISO/IEC 60754-2 Acidity

ISO/IEC 61034-4 Smoke Density

3rd Party verification of Fire safety/environmental tests listed above must be provided as part of the bid response.

The cable and cordage shall be UTP components that do not include internal or external shields, screened components or drain wires.

The horizontal cable shall have a unique print string on the cable jacket. This unique identifier shall also be used for on-line reference to a full set of factory tests that were performed on a sample from the same mater reel. The test parameters shall include NEXT, PSNEXT, Return Loss, Attenuation, ELFEXT and PSELFEXT. The on-line reference must be available on the SCS vendor public website, such that it can be accessed at any time.

13. Specification for Category 6 Information Outlets

**Standard Compliance**


The Category 6 outlets shall be backward compatible with Category 5E, 5 and 3 cords and cables.

The Category 6 outlets shall be of a universal design supporting T568 A & B wiring.

The Category 6 outlets shall be capable of being in a modular patching situation or as a modular telecommunication outlet (TO) supporting current 10BASE-T, Token Ring, 100 Mbps TP-PMD, 155 Mbps ATM, 622 Mbps ATM using parallel transmission schemes and evolving high-speed, high-bandwidth applications, including Ethernet, 1000BASE-T and 1.2 Gbps ATM.
The Category 6 outlets shall be capable of being installed at either a 45° or a 90° angle in any M-series modular faceplate, frame, or surface-mounted box avoiding the need for special faceplates.

The Category 6 outlets shall have improved pair splitters and wider channel for enhanced conductor placement. The outlet shall also have a low-profile wire cap, which protects against contamination and secures the connection. Multicoloured identification labels shall be available to assure accurate installation.

General specifications:

a. Meets or exceeds the mechanical, electrical, and clearance specifications in FCC Rules and Regulations, Part 68, Subpart F

b. Meet or exceed the Category 6 requirements in ISO/IEC 11801, CENELEC EN 50173, and TIA/EIA568B

C. Certifications: UL Listed

The 8-pin modular (RJ-45) jacks shall comply with IEC 60603-7-4.

The information outlet shall have a Current Rating of 1.5 A at 20°C

The information outlet will have insertion life of 750 cycles minimum.

The information outlet must be able to accept termination of solid conductors with nominal diameter of between 0.40 mm to 0.64 mm (26 to 22 AWG).

The Outlets should support 1.5Amp current further to support the PoE and PoE+ applications

14. Specification for CAT 6 LSZH U/UTP RJ45 Patch Cords

**Standard Compliance**

Patch Cords shall be equipped with 8-pin modular plugs on each end.

All cords shall be round, and consist of copper conductors, tightly twisted into individual pairs.

Nominal cordage diameter shall not exceed 5.92 mm.

Plugs shall be designed with an anti-snap latch to facilitate easy removal during move, add and change processes.

The cordage shall be available in Plenum, Non-Plenum and Low-Smoke, Zero Halogen (LSZH) compatibility.

The LSZH version must comply with the following Fire Safety standards:
ISO/IEC 60332-3-22: Vertical Flame Spread

ISO/IEC 60754-2: Acidity

ISO/IEC 61034-2: Smoke Density

3rd Party verification of the Fire Safety/Environmental tests listed above must be provided as part of the bid response.

The cordage shall be UTP components that do not include internal or external shields, screened components or drain wires.

The patch cords will have insertion life of 750 cycles minimum.

The Patch cords shall be available in Stranded and solid core construction

15. **Specification for CAT 6 Jack Panel**

<table>
<thead>
<tr>
<th><strong>Standard Compliance</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The ganged adapter style patch panel will utilize increments of six RJ-45 style jacks in a common moulded component.</td>
</tr>
<tr>
<td>The patch panel type shall be compliant with IEC 60603-7-4.</td>
</tr>
<tr>
<td>The ganged adapters shall have RJ45 jack in the front and Insulation Displacement Connector (IDC) at the rear of the module.</td>
</tr>
<tr>
<td>The panel must be capable of supporting an upgrade to an intelligent system without any interruption to service due to patch cord removal or terminal block re-termination.</td>
</tr>
<tr>
<td>The upgrade to an intelligent system shall be performed through the addition of an overlay panel that does not require tools for installation.</td>
</tr>
<tr>
<td>Termination managers must be provided with the panel. These termination managers provide proper pair positioning, control, and strain relief features to the rear termination area of the panel.</td>
</tr>
<tr>
<td>3rd Party Verification test certificates shall be provided to show compliance to ISO/IEC 11801 testing for category 6 components.</td>
</tr>
<tr>
<td>When configured in worst-case 100 meter channels with full cross-connects and consolidation points with the other products proposed in this tender, the panel shall be capable of delivering the minimum guaranteed channel performance.</td>
</tr>
</tbody>
</table>
16. 42/15/12 U Closed Rack (2 Type of 42 U 800 X 800 & 800 X 1000 & 600 x 600 15/12 U)

<table>
<thead>
<tr>
<th>Standard Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Post 19” 42U Closed rack, with copper &amp; fiber cable management accessories &amp; 19” Closed Wall Mount Rack (15U/12U)</td>
</tr>
<tr>
<td>2 Nos. of 1U power distribution box, with 10 x IEC - C13 sockets &amp; with 32Amp MCB- terminating on a IP56 power sockets</td>
</tr>
<tr>
<td>1 No. Horizontal PDU with 5/15Amp Universal Sockets with 32Amp MCB</td>
</tr>
<tr>
<td>Front mounting PVC Cable managers/ guide</td>
</tr>
<tr>
<td>Integral Cable management ducts/ arms (on either side) with covers</td>
</tr>
<tr>
<td>Cantilever Tray x 1 (19” / 1U/ 255mm - D)</td>
</tr>
<tr>
<td>Cable retention bobbins X 5 (both sides) + Window Molding x 6</td>
</tr>
<tr>
<td>Cable Hangers (set of 3) x 2 (Right &amp; left side one set each)</td>
</tr>
<tr>
<td>Bar, Earthing 42U</td>
</tr>
<tr>
<td>Mounting Hardware (Pack of 10) x 5</td>
</tr>
<tr>
<td>IP65 Rated Outdoor if used in outdoor environment (Weather resistant)</td>
</tr>
</tbody>
</table>

- Testing & Commissioning of Passive Components:

All the passive components shall have their Testing reports from the OEM with Batch No. There shall be the proper ferruling and Numbering on the Cat 6 /fiber cables. There Shall be proper dressing of the cables and equipment management inside the racks.

The Cat 6 cable installation measurements shall be done through penta scanning with standard parameters and shall have the OEM certification for the installation of all the components.

The optical fiber cable installation shall be checked by the OTDR machine and the reports shall meet all the parameters of the technical data sheet of the Cable and shall have the OEM certification for the installation.

After installation & OEM certification Commissioning of the passive components shall be completed.
ACTIVe COMPONENTs

TECHNICAL SPECIFICATIONS FOR ACTIVE COMPONENTS

Firewall with Unified Threat Management (UTM)

<table>
<thead>
<tr>
<th>S.N.</th>
<th>TECHNICAL SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The UTM solution should be Hardware based, Reliable, purpose-built security appliance with hardened operating system that eliminates the security risks associated with general-purpose operating systems.</td>
</tr>
<tr>
<td>2</td>
<td>Should support 1:1 high availability.</td>
</tr>
<tr>
<td>3</td>
<td>Should have minimum 6 x 10G supporting SFP+ interfaces &amp; 8 x 1G BaseT RJ45 ports to cater to connectivity from multiple service providers and load balance them.</td>
</tr>
<tr>
<td>4</td>
<td>The Firewall should have ultra-low latency (~ &lt; 5 micro seconds).</td>
</tr>
<tr>
<td>5</td>
<td>The Firewall should support IPSEC &amp; SSL VPN, inbound and outbound both. The IPSEC VPN should deliver at least 20 Gbps throughput to ensure connectivity with Multiple colleges / University catering to Data / Voice traffic over IPSEC tunnel.</td>
</tr>
<tr>
<td>6</td>
<td>The Firewall should be able to handle very high concurrent sessions like 20 Million or above and at least 400,000 of new sessions per second.</td>
</tr>
<tr>
<td>7</td>
<td>The solution should support Virtualization with 10 Virtual contexts scalable to 250 to help University use the logical Firewalls for internal / student projects run isolated with each other.</td>
</tr>
<tr>
<td>8</td>
<td>The proposed solution should have integrated IPS module with at least 10Gbps of throughput for deep pack inspection of traffic and also should be able to inspect encrypted SSL traffic.</td>
</tr>
<tr>
<td>9</td>
<td>The solution should have at least 5 Gbps of Threat Protection throughput and the so that the entire traffic is scanned before reaching the end user. The antivirus engine should be able to inspect the encrypted traffic like HTTPS, SMTPS, POP3s, IMAPs, FTPs etc.</td>
</tr>
<tr>
<td>10</td>
<td>The proposed system should have integrated Web Content Filtering solution which can be used to block any unwanted sites / category of sites to adhere to University IT guidelines.</td>
</tr>
<tr>
<td>11</td>
<td>The Firewall &amp; IPSEC VPN module shall belong to product family which minimally attain Internet Computer Security Association (ICSA) Certification or equivalent</td>
</tr>
</tbody>
</table>
The proposed system should have modules/Licenses for integrated Web Content Filtering along with IPS, Application Control, Antivirus / Malware Protection & Anti spam.

Proposed solution should be an Appliance/Virtual Machine based solution. In case of Virtual Machine based, required server must be quoted by bidder.

Should have direct OEM TAC support and hardware replacement warranty for 5 Years.

1. Core Switch

<table>
<thead>
<tr>
<th>S. N.</th>
<th>TECHNICAL SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The proposed Switch should be a chassis based and have minimum 4 interface slots and 2 supervisor slots.</td>
</tr>
<tr>
<td>2</td>
<td>Switch should have 48x 1/10G SFP+ Ports, 48x 1G/10G Base-T RJ45 and 8x 40 Gig QSFP+ (for switch to switch inter connectivity) ports spread across two cards. 24 nos of single mode LR transceivers should be populated from day 1.</td>
</tr>
<tr>
<td>4</td>
<td>Switch should have minimum 2TB per interface slot throughput on Day 1. Switch should be scalable to support additional 96 x10G Ports or 48 x40G Ports or 8 x100G Ports at line rate performance.</td>
</tr>
<tr>
<td>5</td>
<td>The proposed line-cards must have non-blocking and wire-speed performance for all packet sizes for IPv4 &amp; IPv6 traffic and should have distributed forwarding architecture.</td>
</tr>
<tr>
<td>6</td>
<td>Should have redundant and replaceable Supervisor / CPU, Management Modules, Replaceable Fabric Modules/ Power Supply and Fans to provide full redundancy and high availability. The performance of the switch should not degrade in case of any failure.</td>
</tr>
<tr>
<td>7</td>
<td>Chassis should support 100G interface line-cards for future connectivity requirement without any replacement in hardware configuration.</td>
</tr>
<tr>
<td>8</td>
<td>Switch should have IPv4 &amp; IPv6 static routes, OSPF, OSPFv3, PBR, PIM-SM / DM, BGP and VRF.</td>
</tr>
<tr>
<td>9</td>
<td>Should support Layer 2 protocols 802.1d, 802.1s, 802.1w and 802.3ad.</td>
</tr>
<tr>
<td>10</td>
<td>Switch should support minimum 8 hardware queues per port for applying various traffic prioritizations through QoS.</td>
</tr>
<tr>
<td>11</td>
<td>Switch should support minimum 2K ACL’s, 4K Multicast and 8K Unicast Routes for IPv4 and IPv6.</td>
</tr>
</tbody>
</table>

13. Should be upgradable to support Open Flow or equivalent functionality, to support SDN (Software Defined Networking). The SDN functionality shall be native to switch.

14. Should have NetFlow/sflow to support 64K entries functionality for traffic monitoring.

15. The proposed switch should be IPv6 logo certified. Desirable: EAL2/NDPP/NDcPP certification.

### 2. Distribution Switch

<table>
<thead>
<tr>
<th>S. N.</th>
<th>TECHNICAL SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Switch should support stacking with dedicated stacking ports and 120Gbps of stacking bandwidth additional to above mentioned data and uplink ports.</td>
</tr>
<tr>
<td>2</td>
<td>Switch should have Operating Temperature of 0-45 Degree Centigrade</td>
</tr>
<tr>
<td>4</td>
<td>Switch ports should be populated with 12 x 1G Multi Mode (SX) transceiver for access layer uplinks &amp; with 4x10G Single Mode Transceivers (LR) for core layer and distribution ring uplinks from day 1.</td>
</tr>
<tr>
<td>5</td>
<td>The proposed interfaces must have non-blocking and wire-speed performance for all packet sizes for IPv4 &amp; IPv6 traffic and should have distributed forwarding architecture.</td>
</tr>
<tr>
<td>6</td>
<td>Should have redundant internal Power Supply and Fans.</td>
</tr>
<tr>
<td>7</td>
<td>Switch should have IPv4 &amp; IPv6 static routes, OSPF, OSPFv3, PBR and PIM-SM / DM.</td>
</tr>
<tr>
<td>8</td>
<td>Should support Layer 2 protocols 802.1d, 802.1s, 802.1w and 802.3ad.</td>
</tr>
<tr>
<td>9</td>
<td>Switch should support minimum 8 hardware queues per port for applying various traffic prioritization through QoS.</td>
</tr>
<tr>
<td>10</td>
<td>Switch should support SP Queuing, minimum 2K ACL’s, 4K Multicast and WRED/WTD. Network OS, 8K Unicast Routes, IPv4 and IPv6 compliant.</td>
</tr>
<tr>
<td>11</td>
<td>Should support Port Security and RADIUS / TACACS integration.</td>
</tr>
<tr>
<td>12</td>
<td>Should be upgradable to support Open Flow or equivalent functionality, to support SDN (Software Defined Networking). The SDN functionality shall be native to switch.</td>
</tr>
</tbody>
</table>
native to switch

<table>
<thead>
<tr>
<th>S. N.</th>
<th>TECHNICAL SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Should have minimum 48x 10/100/1000 BaseT PoE/PoE+ RJ45 Ports (minimum 740W) plus 2x 1/10G BaseX SFP+ Ports populated with 2 nos 1G (SX) SFP. Switch would use 1G uplinks on day 1 and be upgradable to 10G operations in future.</td>
</tr>
<tr>
<td>2</td>
<td>Should have dedicated 48 Gbps of stacking bandwidth (excluding uplink ports) proposed with stacking cable. Stacking should support upto 6 Stacking members</td>
</tr>
<tr>
<td>3</td>
<td>Switch should have Operating Temperature of 0-45 Degree Centigrade</td>
</tr>
<tr>
<td>4</td>
<td>Switch should support External/Internal Redundant Power Supply</td>
</tr>
<tr>
<td>5</td>
<td>The proposed interfaces must have non-blocking and wire-speed performance for all packet sizes for IPv4 &amp; IPv6 traffic and should have distributed forwarding architecture.</td>
</tr>
<tr>
<td>6</td>
<td>Should support Layer 2 protocols IEEE 802.1s, 802.1w, 802.3ad, 802.1x, 802.1p, 802.1Q, 802.3, 802.3u, 802.3ab, 802.3z.</td>
</tr>
<tr>
<td>7</td>
<td>Switch should have IPv4 &amp; IPv6 static routes from day 1</td>
</tr>
<tr>
<td>8</td>
<td>Switch should have minimum 1K ACL’s and 1K IPv4 and IPv6 multicast groups.</td>
</tr>
<tr>
<td>9</td>
<td>Switch should support minimum 8 hardware queues per port for applying various traffic prioritization through QoS. Switch should support SP Queuing</td>
</tr>
<tr>
<td></td>
<td>TECHNICAL SPECIFICATION</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------</td>
</tr>
<tr>
<td><strong>10</strong></td>
<td>Should support 802.1x authentication, Port Security and RADIUS / TACACS integration.</td>
</tr>
<tr>
<td><strong>11</strong></td>
<td>Should be upgradable to support Open Flow or equivalent functionality, to support SDN (Software Defined Networking). The SDN functionality shall be native to switch.</td>
</tr>
<tr>
<td><strong>12</strong></td>
<td>Should have NetFlow / sFlow/equivalent functionality for traffic monitoring.</td>
</tr>
<tr>
<td><strong>13</strong></td>
<td>Switch should support port security, DHCP snooping, Dynamic ARP inspection, IP Source guard, BPDU Guard, Spanning tree root guard and IPv6 First Hop Security.</td>
</tr>
<tr>
<td><strong>14</strong></td>
<td>The proposed switch should be IPv6 logo certified. Should have EAL2/NDPP/NDcPP certification from Day 1.</td>
</tr>
<tr>
<td><strong>15</strong></td>
<td>Should have direct OEM 24x7x365 TAC support with software update and NBD Advanced hardware replacement warranty for 5 Years.</td>
</tr>
</tbody>
</table>

### 4. 48 Port Layer 2 Switch

<table>
<thead>
<tr>
<th>S. N.</th>
<th>TECHNICAL SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong></td>
<td>Should have minimum 48x 10/100/1000 BaseT RJ45 Ports plus 2x 1/10G BaseX SFP+ Ports populated with 2 nos 1G (SX) SFP. Switch would use 1G uplinks on day 1 and be upgradable to 10G operations in future.</td>
</tr>
<tr>
<td><strong>2</strong></td>
<td>Should have dedicated 48 Gbps of stacking bandwidth (excluding uplink ports) proposed with stacking cable. Stacking should support upto 6 Stacking members</td>
</tr>
<tr>
<td><strong>3</strong></td>
<td>Switch should have Operating Temperature of 0-45 Degree Centigrade</td>
</tr>
<tr>
<td><strong>4</strong></td>
<td>Switch should support External/Internal Redundant Power Supply</td>
</tr>
<tr>
<td><strong>5</strong></td>
<td>The proposed interfaces must have non-blocking and wire-speed performance for all packet sizes for IPv4 &amp; IPv6 traffic and should have distributed forwarding architecture.</td>
</tr>
<tr>
<td><strong>6</strong></td>
<td>Should support Layer 2 protocols IEEE 802.1s, 802.1w, 802.3ad, 802.1x, 802.1p, 802.1Q, 802.3, 802.3u, 802.3ab, 802.3z.</td>
</tr>
<tr>
<td><strong>7</strong></td>
<td>Switch should have IPv4 &amp; IPv6 static routes from day 1</td>
</tr>
<tr>
<td><strong>8</strong></td>
<td>Switch should have minimum 1K ACL’s and 1K IPv4 and IPv6 multicast</td>
</tr>
<tr>
<td>S. N.</td>
<td>TECHNICAL SPECIFICATION</td>
</tr>
<tr>
<td>------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>1</td>
<td>Should have minimum 24 x 10/100/1000 BaseTPoE/PoE+ RJ45 Ports (minimum 370W) plus 2x 1/10G BaseX SFP+ Ports populated with 2 nos 1G (SX) SFP. Switch would use 1G uplinks on day 1 and be upgradable to 10G operations in future.</td>
</tr>
<tr>
<td>2</td>
<td>Should have dedicated 48Gbps of stacking bandwidth (excluding uplink ports) proposed with stacking cable. Stacking should support upto 6 Stacking members</td>
</tr>
<tr>
<td>3</td>
<td>Switch should have Operating Temperature of 0-45 Degree Centigrade</td>
</tr>
<tr>
<td>4</td>
<td>Switch should support External/Internal Redundant Power Supply</td>
</tr>
<tr>
<td>5</td>
<td>The proposed interfaces must have non-blocking and wire-speed performance for all packet sizes for IPv4 &amp; IPv6 traffic and should have distributed forwarding architecture.</td>
</tr>
<tr>
<td></td>
<td>Requirement</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>6</td>
<td>Should support Layer 2 protocols IEEE 802.1s, 802.1w, 802.3ad, 802.1x, 802.1p, 802.1Q, 802.3, 802.3u, 802.3ab, 802.3z.</td>
</tr>
<tr>
<td>7</td>
<td>Switch should have IPv4 &amp; IPv6 static routes from day 1</td>
</tr>
<tr>
<td>8</td>
<td>Switch should have minimum 1K ACL’s and 1K IPv4 and IPv6 multicast groups.</td>
</tr>
<tr>
<td>9</td>
<td>Switch should support minimum 8 hardware queues per port for applying various traffic prioritization through QoS. Switch should support SP Queuing and WRED/WTD.</td>
</tr>
<tr>
<td>10</td>
<td>Should support 802.1x authentication, Port Security and RADIUS / TACACS integration.</td>
</tr>
<tr>
<td>11</td>
<td>Should be upgradable to support OpenFlow or equivalent functionality, to support SDN (Software Defined Networking). The SDN functionality shall be native to switch</td>
</tr>
<tr>
<td>12</td>
<td>Should have NetFlow / sFlow/ Equivalent functionality for traffic monitoring.</td>
</tr>
<tr>
<td>13</td>
<td>Switch should support port security, DHCP snooping, Dynamic ARP inspection, IP Source guard, BPDU Guard, Spanning tree root guard and IPv6 First Hop Security.</td>
</tr>
<tr>
<td>14</td>
<td>The proposed switch should be IPv6 logo certified. Should have EAL2/NDPP/NDcPP certification from Day 1.</td>
</tr>
<tr>
<td>15</td>
<td>Should have direct OEM 24x7x365 TAC support with software update and NBD Advanced hardware replacement warranty for 5 Years.</td>
</tr>
</tbody>
</table>
CHAPTER - 9

TECHNICAL SPECIFICATION - EXTERNAL STREET LIGHTING SYSTEM

- **Scope of Work:**

  The scope of works under External Street Lighting System requires illumination of all external areas like streets, roads, entrance gates, boundary walls, parks, gardens, landscaping, porches, building facades, walkways, pathways etc., which shall be illuminated conforming to NBC 2016, ECBC 2017 and CPWD specifications maintaining required Lux levels. Suitable LED fixtures shall only be used with inbuilt harmonic suppression mechanism for external area illumination. Solar and conventional street light poles, bollards, gate lights, post-top lantern etc. shall be used for this purpose keeping in view aesthetical and architectural requirements. The external lighting shall be fed from outdoor type feeder panels and automatically controlled through 24-hour Digital/Astronomical Timers.

  All solar & conventional street light poles of single arm /double arm/triple arm, as required shall be GI Octagonal with heights as per relevant IS Codes, NBC Code & ECBC.

- **Standard Galvanised Octagonal Poles**

  Octagonal poles shall be designed as per ILE TR7 & BS5649 for structural design & as per IS875 (Part III), 1987 for dynamic loading.

  The pole shaft shall be made single piece MS structure continuously tapered having polygonal (8/12 sides) cross section and a single longitudinal welding. The welding will be done as per BS 5135 / IS 9595. No circumferential welding shall be allowed in the pole shaft. The MS shall conform to BSEN 100025/100027. The structure shall be single hot dip galvanized as per BS 729 / IS 2629. A suitably designed door shall be provided at approximate 700mm height from the pole base. The door opening will be suitably reinforced for structural strength. The door shall be flushed with pole external surface and shall provide easy access for electrical connections at a maintainable height. A Suitable base flange will be welded and plate reinforcements will be provided between base flange & pole. Foundation accessories will be as per IS 1367.

<table>
<thead>
<tr>
<th>POLE DETAILS</th>
<th>FOUNDATION BOLT DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>POLE DESCRIPTION</td>
<td>HEIGHT</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>H</td>
</tr>
<tr>
<td>----------------------</td>
<td>------</td>
</tr>
<tr>
<td>3 MTR GI OCTAGONAL POLE</td>
<td>3000</td>
</tr>
<tr>
<td>4 MTR GI OCTAGONAL POLE</td>
<td>4000</td>
</tr>
<tr>
<td>5 MTR GI OCTAGONAL POLE</td>
<td>5000</td>
</tr>
<tr>
<td>6 MTR GI OCTAGONAL POLE</td>
<td>6000</td>
</tr>
<tr>
<td>7 MTR GI OCTAGONAL POLE</td>
<td>7000</td>
</tr>
<tr>
<td>8 MTR GI OCTAGONAL POLE</td>
<td>8000</td>
</tr>
<tr>
<td>9 MTR GI OCTAGONAL POLE</td>
<td>9000</td>
</tr>
<tr>
<td>10 MTR GI OCTAGONAL POLE</td>
<td>10000</td>
</tr>
<tr>
<td>11 MTR GI OCTAGONAL POLE</td>
<td>11000</td>
</tr>
<tr>
<td>12 MTR GI OCTAGONAL POLE</td>
<td>12000</td>
</tr>
</tbody>
</table>
NOTE: ALL DIMENSIONS IN MM

<table>
<thead>
<tr>
<th>System Wattage</th>
<th>15Watts</th>
<th>18Watts</th>
<th>21Watts</th>
<th>24Watts</th>
<th>27Watts</th>
<th>30Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Lumen Output</td>
<td>1600</td>
<td>1900</td>
<td>2200</td>
<td>2600</td>
<td>2900</td>
<td>3150</td>
</tr>
<tr>
<td>Charge Controller Type</td>
<td>MPPT (DIM)</td>
<td>MPPT (DIM)</td>
<td>MPPT (DIM)</td>
<td>MPPT (DIM)</td>
<td>MPPT (DIM)</td>
<td>MPPT (DIM)</td>
</tr>
<tr>
<td>Charge controller efficiency</td>
<td>&gt;96%</td>
<td>&gt;96%</td>
<td>&gt;96%</td>
<td>&gt;96%</td>
<td>&gt;96%</td>
<td>&gt;96%</td>
</tr>
<tr>
<td>LED Driver efficiency</td>
<td>&gt;96%</td>
<td>&gt;96%</td>
<td>&gt;96%</td>
<td>&gt;96%</td>
<td>&gt;96%</td>
<td>&gt;96%</td>
</tr>
<tr>
<td>No of Leds</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>No Load current from battery</td>
<td>&lt;10mA</td>
<td>&lt;10mA</td>
<td>&lt;10mA</td>
<td>&lt;10mA</td>
<td>&lt;10mA</td>
<td>&lt;10mA</td>
</tr>
<tr>
<td>Housing</td>
<td>LM6 PDC Housing</td>
<td>LM6 PDC Housing</td>
<td>LM6 PDC Housing</td>
<td>LM6 PDC Housing</td>
<td>LM6 PDC Housing</td>
<td>LM6 PDC Housing</td>
</tr>
<tr>
<td>Front Cover</td>
<td>Toughened Glass</td>
<td>Toughened Glass</td>
<td>Toughened Glass</td>
<td>Toughened Glass</td>
<td>Toughened Glass</td>
<td>Toughened Glass</td>
</tr>
<tr>
<td>Ingress Protection</td>
<td>IP66, Class I</td>
<td>IP66, Class I</td>
<td>IP66, Class I</td>
<td>IP66, Class I</td>
<td>IP66, Class I</td>
<td>IP66, Class I</td>
</tr>
<tr>
<td>Life</td>
<td>50,000Hrs @ L70</td>
<td>50,000Hrs @ L70</td>
<td>50,000Hrs @ L70</td>
<td>50,000Hrs @ L70</td>
<td>50,000Hrs @ L70</td>
<td>50,000Hrs @ L70</td>
</tr>
<tr>
<td>CCT</td>
<td>5700K (+/-5SDCM)</td>
<td>5700K (+/-5SDCM)</td>
<td>5700K (+/-5SDCM)</td>
<td>5700K (+/-5SDCM)</td>
<td>5700K (+/-5SDCM)</td>
<td>5700K (+/-5SDCM)</td>
</tr>
<tr>
<td>CRI</td>
<td>&gt;70</td>
<td>&gt;70</td>
<td>&gt;70</td>
<td>&gt;70</td>
<td>&gt;70</td>
<td>&gt;70</td>
</tr>
<tr>
<td><strong>Solar Panel</strong></td>
<td>75 WP</td>
<td>75WP</td>
<td>100WP</td>
<td>120WP</td>
<td>120WP</td>
<td>120WP</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------</td>
<td>------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td><strong>Battery</strong></td>
<td>75AH</td>
<td>75 AH</td>
<td>100AH</td>
<td>100AH</td>
<td>100AH</td>
<td>120 AH</td>
</tr>
<tr>
<td><strong>Battery Box</strong></td>
<td>Sheet Metal</td>
<td>Sheet Metal</td>
<td>Sheet Metal</td>
<td>Sheet Metal</td>
<td>Sheet Metal</td>
<td>Sheet Metal</td>
</tr>
<tr>
<td><strong>Autonomy (battery backup)</strong></td>
<td>3 days</td>
<td>3 days</td>
<td>3 days</td>
<td>3 days</td>
<td>3 days</td>
<td>3 days</td>
</tr>
<tr>
<td><strong>Pole Height (Above ground)</strong></td>
<td>5 MTS OCTAGONAL 4 MM THICK</td>
<td>5 MTS OCTAGONAL 4 MM THICK</td>
<td>5 MTS OCTAGONAL 4 MM THICK</td>
<td>5/6 MTS OCTAGONAL 4 MM THICK</td>
<td>5/6 MTS OCTAGONAL 4 MM THICK</td>
<td></td>
</tr>
<tr>
<td><strong>Other accessories</strong></td>
<td>Battery stand, Panel holder, Arm 0.5 mts 5 degree tilt</td>
<td>Battery stand, Panel holder, Arm 0.5 mts 5 degree tilt</td>
<td>Battery stand, Panel holder, Arm 0.5 mts 5 degree tilt</td>
<td>Battery stand, Panel holder, Arm 0.5 mts 5 degree tilt</td>
<td>Battery stand, Panel holder, Arm 0.5 mts 5 degree tilt</td>
<td>Battery stand, Panel holder, Arm 0.5 mts 5 degree tilt</td>
</tr>
<tr>
<td><strong>Visual Indication (LED)</strong></td>
<td><strong>PV Charging</strong></td>
<td><strong>Provided</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td>-----------------</td>
<td>--------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Board Over Temperature Fault:</td>
<td>To be Provided</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Battery Not Connect Fault</td>
<td>To be Provided</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Battery Over Voltage Fault</td>
<td>To be Provided</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Panel Over Voltage Fault</td>
<td>To be Provided</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Load short circuit protection</td>
<td>To be Provided</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Load OVP</td>
<td>To be Provided</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Battery under Voltage Fault</td>
<td>To be Provided</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Environmental</strong></th>
<th><strong>Operating Temperature Range</strong></th>
<th>-0°C to +50°C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Storage Temperature Range</strong></td>
<td>-20°C to +85°C</td>
</tr>
<tr>
<td></td>
<td><strong>Humidity</strong></td>
<td>95%RH</td>
</tr>
<tr>
<td></td>
<td><strong>Battery Temperature Compensation</strong></td>
<td>To be Provided</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Ingress Protection</strong></th>
<th><strong>Ingress Protection</strong></th>
<th>IP66</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Embossing</strong></th>
<th><strong>Luminaire must be embossed with original equipment Manufacturer name</strong></th>
<th>To be Provided</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Dimming Feature</strong></th>
<th><strong>50% auto Dim after 5hrs.</strong></th>
<th>To be Provided</th>
</tr>
</thead>
</table>

- **Power cabling for External illumination:**

  The power shall be fed to Street Light Poles, High Mast Poles, Hybrid Solar street Light Poles, Bollards, Post Top lanterns, Gate Lights, Façade Lights, Walk way lights etc through suitable size aluminium armoured XLPE insulated power.
cables, laid underground as per CPWD Specifications. Suitable Feeder Pillars shall be provided to feed various circuits of street lights.

- **Street Light Pole Height & distance between poles:**

  Street Light Poles, High Mast Poles, Hybrid Solar street Light Poles, Bollards, Post Top Lanterns of suitable height shall be provided to achieve illumination with required Lux levels in the external areas as per CPWD, NBC 2016 & ECBC norms. Distance between street light poles shall be as per CPWD, NBC 2016 & ECBC norms as applicable.

  **Inspection:** Street Light Poles, High Mast Poles, Hybrid Solar Street Light Poles etc shall be offered for inspection by HITES Engineers at manufacturer’s works before final dispatch to site as per terms of the contract.

  **Drawings:** Site Layout drawings and Single Line diagrams shall be prepared and submitted for approval of Engineer-In-charge by the contractor for the Street Light Poles, High Mast Poles, Hybrid Solar street Light Poles, Bollards, Post Top lanterns, Gate Lights, Façade Lights, Walk Way lights etc. The drawings shall be got approved from Engineer-In-charge before commencement of works at site.

- **Applicable IEC Standards:**
  
  i. IEC 61215 latest: Solar Panel
  
  ii. IEC 61347-2-13 : LED driver safety
  
  iii. IEC 62384 : LED driver performance
  
  iv. CISPR 15 : Radio disturbance characteristics
  
  v. IEC 61547 : EMC immunity requirements
  
  vi. IEC 60598 : General requirements and test

**Solar Street Light Poles – All In One Type:**

**SPECIFICATION FOR 40W ALL IN ONE INTEGRATED SOLAR STREET LIGHTS (Single Arm- STREET LIGHTS)**

Providing, supplying, fixing and installing LED INTEGRATED Solar Street light 36-40 Watt inbuilt charge controller, with health monitoring system, over charging protection enabled with Bluetooth technology installed on high mast of 6 metres high fixing vertically on selected location with following specifications:-:
• LED Luminary-40W, LED Light Output-25ux at 6 metres Height, LED Life Span > 50,000 hrs. LED Efficiency > 120 lm/W, Operating Voltage 12V DC to 13V DC with necessary accessories.

• Solar MONO Panels: 40Wp Size 1120 X 305 X 140 mm

• Battery-LiFePO4, Per fixture Minimum 12.8V, 27 Ah, Duty Cycle-12 hours/day, Autonomy 2 days, Ingress Protection IP65 with necessary accessories.

• GI Decorative pole - Mounting Height 6m, Hot Deep Galvanized with necessary accessories with single decorative arm.
CHAPTER - 10

TECHNICAL SPECIFICATION - UPS SYSTEM

- Quality power Supply

The UPS shall be ON-LINE double conversion with filter, stabilized and reliable voltage that is free from all mains interference (Over voltage, frequency variations, voltage drops).

The battery bank should have provision for future expansions. The UPS shall have Optional filters, Isolation Transformer module, LCD-based remote control panel etc.

- The Operating mode of UPS

It should operate in following on-line operating mode:

**Economy Mode:** The UPS should use Line Interactive technology, i.e. the load is powered from the mains; the energy consumption is reduced with a subsequent improvement in efficiency.

**Smart active mode:** The UPS should automatically selects On Line or Line Interactive operating mode according to the quality of the mains supply, by monitoring the number, frequency and type of disturbances at the mains power input.

**Stand-by-off mode:** With the mains available the UPS should normally not powered and consequently the power consumption is almost nil. Only when the mains fails or falls outside a preset range, does the inverter take over using power from the batteries. This mode shall be suitable for Emergency escape lighting as per standard EN 50171.

- Maximum safety for personnel

There should be a feedback protection device in the UPS to prevent any voltage back feed in the upstream distribution board, thus ensuring the maintenance personal.

For advanced communication there shall be software system which displays the most important information such as the input and output Voltage, the load applied, the remaining back-up time, etc. It should also be able to provide information even in the event of a failure, to support the fault diagnostics.

It should also contain the following hardware interfaces:
• RS 232 serial port
• Dry contacts
• EPO (Emergency Power Off)
• Contact for UPS shutdown using the remote emergency button.

The UPS should have Mimic Panel for status and alarm, control and commands, input, output, battery status and settings.

• **Low Input Harmonic Distortion**

The UPS shall have the Power Factor Correction (PFC), standard on all modules, so that the input power factor level to 0.95 for any load percentages so that it is ideal in conjunction with motor generator or in installation with other sensitive loads. There shall be built in Active Filter designed to reduce the level of THDi to less than 4% and to increase the input power factor up to 0.99.

This Active filter shall be based on the IGBT Technologies controlled by the Digital Signal Processor (DSP). This DSP instantly monitors and controls the inputs current absorbed by the UPS in order to eliminate the unlike harmonics and maintain the THDi less than 4%. With the effect of Active Filter the UPS can also be connected to the low loads. These active filters shall be fitted inside the UPS so that no additional footprint is required.

• **UPS & its features:**

• **The input requirements of the UPS are as follows:**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>400 V three-phase + Neutral</td>
</tr>
<tr>
<td>Voltage tolerance</td>
<td>± 20%+</td>
</tr>
<tr>
<td>Frequency</td>
<td>45-65 Hz</td>
</tr>
<tr>
<td>Current distortion</td>
<td>&lt;4% with active filter</td>
</tr>
<tr>
<td>Power factor</td>
<td>0.99 with active filter</td>
</tr>
</tbody>
</table>

• **The Bypass of the UPS are as follows:**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>400 V three-phase + N</td>
</tr>
<tr>
<td>Specification</td>
<td>Details</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>Phases number</td>
<td>3 + N</td>
</tr>
<tr>
<td>Voltage tolerance</td>
<td>± 15%</td>
</tr>
<tr>
<td>Rated frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Frequency tolerance</td>
<td>± 2%</td>
</tr>
<tr>
<td>By-pass</td>
<td>Static and manual for maintenance</td>
</tr>
<tr>
<td>Transfer time</td>
<td>Nil</td>
</tr>
</tbody>
</table>

- **The Battery for the UPS are as follows:**
  - Type of battery          | maintenance-free sealed lead acid |
  - Battery blocks           | 12 V                              |
  - Recharge time minimum   | 6 Hr                              |

- **The Output of UPS are as follows:**
  - Rated power             | Asper General arrangement         |
  - Active power            | Asper General arrangement         |
  - Phases number           | 3 + N                             |
  - Waveform                | Sinewave                          |
  - Rated voltage           | 415 V                             |
  - Frequency               | 50 Hz                             |
  - Dynamic stability       | ± 5%0.                            |
  - Static stability        | ± 1% 00                           |
  - Crest factor            | 3 : 1                             |
  - Overload                | 125% for 10 min                   |

- **The System of UPS is as follows:**
  - AC/AC efficiency       | 92% in On-line mode               |
  - Noise                  | 50-56 Db at 1 M distance          |
<table>
<thead>
<tr>
<th>Specification</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature</td>
<td>-2º - 45ºC</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>95% non-condensing</td>
</tr>
<tr>
<td>Remote controls</td>
<td>EPO &amp; Bypass</td>
</tr>
<tr>
<td>Remote signals</td>
<td>volt free contacts</td>
</tr>
<tr>
<td>Protection degree</td>
<td>IP20</td>
</tr>
<tr>
<td>Communication</td>
<td>Double RS232/C + slot for SNMP Adapter</td>
</tr>
</tbody>
</table>

- **The Standard of UPS are as follows:**
  
  i. Safety EN 62040-1
  
  ii. EMC IEC 62040-2
  
  iii. EN 50091-2 lev. A
  
  iv. Directives 73/23, 93/68, 89/336 EEC
  
  v. EN 62040-3.

All outlets for power in IT Room, Server Room, EPABX room, Fire Officer Control Room & Security Room etc. shall be fed from UPS supply.
CHAPTER - 11

TECHNICAL SPECIFICATIONS - FIRE ALARM SYSTEM

- GENERAL

A. The specifications includes furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm network equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Network Fire Alarm Control Panels (FACP), Network Reporting Terminals (NRT), Network Liquid Crystal Display (NLCD), auxiliary control devices, annunciators, and wiring as shown on the drawings and specified herein.

B. The fire alarm system shall comply with requirements of IS:2189:1999 & 1996 NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification, or the stringent one of the two specification in case of any discrepancy. The system shall be electrically supervised and monitor the integrity of all conductors.

C. Fire Alarm System shall be integrated with P.A. system. A digitized pre-recorded voice message shall notify occupants that a fire condition has been reported. The message shall instruct the occupants with emergency instructions. Emergency manual voice override shall be provided.

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

E. Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Alarm Control Room and designated personnel.

F. The FACP shall be active/interrogative-type systems where each transponder is repetitively scanned, causing a signal to be transmitted to the fire alarm control panel node indicating that the transponder and its associated initiating device and notification appliance circuit wiring is functional. Loss of this signal at the FACP shall result in a trouble indication on both the FACP display and at the network display, as specified hereinafter for the particular input.

G. The system shall be arranged such that not less than 20 percent additional transponders may be inserted into any network communication loop.
H. The installing company shall employ technicians on site to guide the labours and to ensure the systems integrity.

- **SCOPE:**

  A new network intelligent reporting, microprocessor controlled fire detection system compatible with PA system emergency voice alarm communication network shall be installed in accordance with the specifications and drawings.

- **Basic Performance:**

  A. Alarm and trouble signals from the FACP, NRT, and NLCD network nodes shall be digitally encoded by listed electronic devices onto a NFPA Style 9 looped multiplex communication system.

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

  C. Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D). Connected by the SLC.

  D. Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z). Connected by the SLC.

  E. Power for initiating devices and notification appliances must be from the main fire alarm control panel, the transponder to which they are connected or to a Field Charging Power Supply (FCPS).

  F. A single ground or open on any system signaling line circuit, initiating device circuit, or notification appliance circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.

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

  H. Digitized electronic signals shall employ check digits or multiple polling.

  I. Transponder devices are to consist of low current, solid-state integrated circuits, and shall be powered locally from a primary power and standby power source.

  J. F.A. System shall be integrated with P.A system & Car Calling system so that it can be used for Emergency evacuation under fire condition.

- **SUBMITTALS**

  A. General:

  All substitute equipment proposed as equal to the equipment specified herein, shall meet or exceed the following standards. For equipment other than that
specified, the contractor shall supply proof that such substitute equipment does in fact equal or exceed the features, functions, performance, and quality of the specified equipment. Two copies of all submittals shall be submitted to the Engineer-in-charge/Engineer for review.

B. Shop Drawings:

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

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

3. Show equipment layout and main control panel, module layout, configurations and terminations.

C. 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 item of equipment and the interconnections between the items of equipment.

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

Approvals will be based on complete submissions of manuals together with shop drawings.

D. 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 2 hours.

Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm network 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. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.

E. Certifications:

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

- **APPLICABLE PUBLICATIONS:**

  The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only.

  A. The fire alarm system shall comply with requirements of NFPA for protected premises signaling systems except as modified and supplemented by this specification. The system field wiring shall be supervised either electrically or by software-directed polling of field devices.

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

  C. Local and State Building Codes.

  D. All requirements of the Authority Having Jurisdiction (AHJ).

- **APPROVALS:**

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

      UL   Underwriters Laboratories Inc
      FM   Factory Manual
      ULC  Underwriters Laboratories Canada
      CPWD Central Public Work Department
      BIS   Bureau of Indian Standards

  B. The fire alarm control panel, network interface and all transponders shall meet the modular labeling requirements of Underwriters Laboratories, Inc. Each subassembly, including all printed circuits, shall include the appropriate UL modular label. Systems which do not include modular labels, which may require return to the manufacturer for system upgrades, and are not acceptable.

- **PRODUCTS

- **EQUIPMENT AND MATERIAL, GENERAL:**

  A. 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 protected premises protective signaling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

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

C. 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:

A. M.S. Conduit:

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

2. Where possible, 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.

3. 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.

4. Wiring for 24 volt 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.

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

The following specifications of Maharashtra Schedule of Rates shall be followed:-

1. WGMA/BW

• Scope
• **Concealing of Rigid steel Conduits:**

• **In walls / flooring:**

Concealing of Rigid steel conduits and erecting in wall, flooring by making chases / grooves/ entries as per approved Method of Construction along with continuous earth wire and all required material including earth clips hardware such as ‘U’ nails, binding wire, fish wire; accessories such as MS junction / inspection boxes, check-nuts, flexible PVC pipe, drawing fish wires and making all piping rigid, refinishing the surface with cement mortar, removing debris from site.

**Material:**

• **Rigid Steel Conduits:**

Rigid steel HG conduit minimum 20mm dia and 16 gauge, ERW grade duly processed for antirust treatment and painted with black enamel paint, accessories for rigid steel conduits such as check nuts, long bends, deep junction boxers for flooring, regular junction boxes for walls; of required ways all of the same make.

• **Earth continuity wire:**

GI wire of 2.5 sq. mm GI earth clips 22 gauge, 100 mm width, for fixing earth wire along the conduits.

• **Junction boxes / Draw – in boxes:**

Junction box shall be 5 sided with removable to plate and of suitable size to accommodate No. of entries; fabricated from 16 SWG CRCA sheet steel earth terminal duly treated with antirust treatment and painted with two coats of red oxide paint. There shall be knock out holes in required numbers and dia for entry of conduit of conduit pipes and arrangement to fix cover plates on it.

• **Hardware:**

‘U’ nails, plumbing and general use nails of required sizes, washers, check-nuts, steel binding wire 20 gauge, GI fish wire, etc.

• **Method of Construction:**

• **Concealing of Rigid Steel conduits:**

• **General:**

Work shall be done in co-ordination with civil work to suit final approved layout. Size of conduit shall be correct depending on number of wires to be drawn. (Table No. 1/1, for Steel conduits) Separate pipe shall be used for each phase in 1-ph distribution and for power and light distribution and also for wiring for other utilities like data, telephone, TV cabling, etc; for which the distance between pipes shall not be less than 300 mm or anti electrostatic partition is to be provided.
Adequate use of conduit accessories shall be made at required locations. Entries in wall shall be at level of corresponding conduit with colour coding as per Table No. 1 / 4(For Visual identification) Flexible conduits shall be used at expansion joints. Erection shall be done as per the layout finalized with minimum sharp bends, with junction boxes at angular junctions and for straight runs at every 4.25 metre; in such manner so as to facilitate drawing of wires. All bending of conduits shall be done approved manner without changing the cross-section.

- **Concealing of Rigid Steel Conduits in walls/ flooring:**

  Chases shall be made in walls of adequate width with cutter and chiseling through it. Necessary finishing of the wall surface shall be done. Work in flooring shall not disturb RCC work, Conduits of adequate size shall be erected with use of appropriate accessories, and hardware like 'U' nails, etc. draw-in / inspection boxes shall be fixed with check-nut, flush with surrounding surface and earthed.

- **Testing:**

- **Earth continuity:**

  Earth continuity shall be ensured at termination point of Earth wire, between the ends of metal conduit.

- **Mode of Measurement:**

  Measurement shall be carried out on the basis per running meter length of conduit.

    a) WGMA/CC-

- **Scope:**

- **Bunch of wires:**

  Providing specified wires and drawing them through provided conduits/ trunking and / or as directed with coated ferrules, harnessing the bunch of wires with necessary material when used in panel boards, duly connecting / terminating with lugs, and testing for safety and beneficial use.

- **Material:**

- **Wires: in conduits/ trunking/ panel boards**

- **Mains/ Sub- Main/ Circuit mains (comprising phase and neutral wires):**

  PVC insulated wire of specified size, minimum FR Grade insulation copper conductor of electrolytic tough pitch (ETP) grade having insulation of 1.1 kV grade, ISI marked of required colour coding as per Table No. 1/5.
- **Wires: Open**

  PVC insulated and PVC sheathed wire of specified size, minimum FR Grade insulation, copper conductor of electrolytic tough pitch (ETP) grade, having insulation of 1.1 kV grade, ISI marked of required colour coding as per Table No. 1/5.

- **Earth Continuity wire:**

  PVC insulated wire minimum FR Grade insulation, copper conductor of electrolytic grade, having insulation of 1.1 kV grade of green/ green yellow colour, ISI marked of required colour coding as per Table No. 1/5.

- **Lugs:**

  Copper lugs of appropriate size & type.

- **Other material:**

  Rubber grommet, bush, harnessing material, flexible conduit etc.

- **Method of Construction:**

- **Bunch of wires:**

- **Drawing of wires: General**

  Specified wires shall be drawn with adequate care. Correct colour coding as per Table No. 1/5 shall be used for phase, neutral and earth. Wires shall not have intermediate joint in between terminals of the accessories. Earth-wire and Return wire (neutral) of two different phases, shall not be drawn in single pipe. Wires shall be terminated in the terminals of accessories only, with appropriate type of size and lugs.

- **Drawing of wires: through PVC conduits.**

  Bush shall be used at pipe opening to protect wire insulation from getting damaged due to burrs/ sharp edges. Number of wires shall not exceed with respect to size of pipe as per Table No. 1/2.

- **Drawing of wires: through Rigid Steel conduits**

  Bush shall be used at pipe opening to protect wire insulation from getting damaged due to burrs/ sharp edges. Number of wires shall not exceed with respect to size of pipe as per Table No. 1/1.

- **Open wire bunch:**
Open wires shall be erected with due care so as to avoid chances of any mechanical manner in panel boards or wherever necessary. For covering lead wires flexible conduit shall be used with gland as per necessity.

- **Testing:**
- **Insulation resistance test:**

  All wiring shall be tested with 500V Megger between phases, phase – neutral and to Earth. IR value shall not be less than 1 M-ohm.

- **Earth continuity:**

  Earth continuity shall be ensured between termination points of Earth wire.

- **Polarity Test:**

  Test shall be carried out for ensuring the correct polarity in switch and plug.

- **Mode of Measurement:**

  Measurement shall be carried out on the basis per running meter length of single wire or bunch as specified.

**Table 1/1**

**Maximum Number of single core 1.1 KV cables that can be drawn in Rigid steel Conduits**

<table>
<thead>
<tr>
<th>Size of cable mm²</th>
<th>Size of Conduit mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Cross Sectional area</td>
<td>No. and dia of wires</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>1.0</td>
<td>1/1.12 Cu</td>
</tr>
<tr>
<td>1.5</td>
<td>1/1.4</td>
</tr>
<tr>
<td>2.5</td>
<td>1/1.8 3 / 1.06 Cu</td>
</tr>
<tr>
<td>Size of cable sq. mm²</td>
<td>Size of conduit mm</td>
</tr>
<tr>
<td>----------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Nominal cross sectional area</td>
<td>No. and dia of wires</td>
</tr>
<tr>
<td>1.0</td>
<td>1/1.12Cu</td>
</tr>
</tbody>
</table>

Note 1: Cu – applicable to only copper cable; Al – applicable to only Aluminium Cable.

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

Note 3: In case of inspection type draw in box has been provided and if the cable is first drawn through one straight conduit, then through the draw in box and then through the second straight conduit such system may be considered as that of straight conduit even if the conduit deflects through the straight by more than 15°.

**Table 1/2**

**Maximum Number of single core 1.1 KV cables that can be drawn in Rigid Non-Metallic Conduits**

<table>
<thead>
<tr>
<th>Size of cable sq. mm²</th>
<th>Size of conduit mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal cross sectional area</td>
<td>No. and dia of wires</td>
</tr>
<tr>
<td>1.0</td>
<td>1/1.12Cu</td>
</tr>
<tr>
<td>Dia. (mm)</td>
<td>Colour Code</td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
</tr>
<tr>
<td>1.5</td>
<td>1/1.4</td>
</tr>
<tr>
<td>2.5</td>
<td>1/1.8</td>
</tr>
<tr>
<td></td>
<td>3/1.06 Cu</td>
</tr>
<tr>
<td>4.0</td>
<td>1/2.24</td>
</tr>
<tr>
<td></td>
<td>7/0.85 Cu</td>
</tr>
<tr>
<td>6</td>
<td>1/2.80</td>
</tr>
<tr>
<td></td>
<td>7/1.06 Cu</td>
</tr>
<tr>
<td>10</td>
<td>11/3.55</td>
</tr>
<tr>
<td></td>
<td>Al 7/1.40 Cu</td>
</tr>
<tr>
<td>16</td>
<td>7/1.70</td>
</tr>
<tr>
<td>25</td>
<td>7/2.24</td>
</tr>
<tr>
<td>35</td>
<td>7/2.50</td>
</tr>
<tr>
<td>50</td>
<td>7/3.0 Al 19/1.80</td>
</tr>
</tbody>
</table>

Note 1: Cu- applicable to only copper cable; Al- applicable to only Aluminium cable.

**Table No. 1/4**

**Colour Coding for Conduits in Wall entry**

<table>
<thead>
<tr>
<th>Conduit For</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light/ Power Circuit</td>
<td>Black</td>
</tr>
<tr>
<td>Security wiring</td>
<td>Blue</td>
</tr>
<tr>
<td>Fire Alarm wiring</td>
<td>Red</td>
</tr>
<tr>
<td>Low voltage circuits</td>
<td>Brown</td>
</tr>
<tr>
<td>UPS circuits</td>
<td>Green</td>
</tr>
</tbody>
</table>
Table 1/5

**Colour code of Wires**

<table>
<thead>
<tr>
<th>Type</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase</td>
<td>Red, yellow, Blue</td>
</tr>
<tr>
<td>Neutral</td>
<td>Black</td>
</tr>
<tr>
<td>Earthing</td>
<td>Green</td>
</tr>
</tbody>
</table>

- **Wire:**

  All fire alarm system wiring must be new, unless specified herein.

  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 1.5 sq.mm. for initiating device circuits and signaling line circuits 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.

  Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).

  Wiring used for the signaling line circuit (SLC) shall be twisted and shielded and installed in conduit unless specifically accepted by the fire alarm equipment manufacturer.

  All field wiring shall be completely supervised.

- **FIRE ALARM CONTROL PANELS AND FIRE CONTROL ROOM:**

  The Fire Alarm Control Panel shall be as per Section 7.33 of IS: 2189.

  Each network FACP 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 detectors, addressable modules, Panel modules including initiating circuit, control circuits, transponders, local and remote operator terminals, printers, annunciators, emergency voice communication systems, and other system controlled devices.

  Each FACP on the network shall perform the following functions:

  1. It shall Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
2. It shall supervise all initiating signaling and notification circuits throughout the facility by way of connection to monitor and control modules.

3. It shall 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 as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.

4. It shall visually and audibly annunciate any trouble, supervisory, security or alarm condition on operator's terminals, panel display, and annunciators.

5. When any of the following condition is detected and reported by one of the system initiating devices or appliances:
   
   i. Fire Alarm Conduits
   ii. Trouble Confirmation
   iii. Supervisory Card
   iv. Security Alarm
   v. Pre Alarm

   Then the following functions shall immediately occur:

   a. The FACP alarm LED on the FACP shall flash.
   
   b. A local piezo-electric indication for the event signal for the event in the FACP shall sound a distinctive Signal.
   
   c. The 960(24X40)-character LCD display on the local FACP node and on the network displays shall indicate all information associated with the fire alarm condition, including the type of alarm point, and its location within the protected premises. This information shall also be displayed on the network reporting terminal. System can be configured without taking the panel offline and shall have the feature of Remote diagnostics via a built-in web server.
   
   d. Printing and 12000 history storage equipment shall log the information associated with the fire alarm control panel condition, along with the time and date of occurrence. The Panel should have Built-in Ethernet Port for Webserver, BACnet and 3D color graphics software.
e. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated on either local outputs or points located on other network nodes.

- General FACP Configuration & Operation:

1. Each FACP node shall include a full featured operator interface control and annunciation panel which shall include a backlit 960 (24X40) character Liquid Crystal Display (LCD), individual, color coded system status LEDs, and an alpha-numeric keypad for field programming and control of the node.

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

3. FACP nodes shall be designed so that it permits continued local operation of remote transponders under both normal and abnormal network communication loop conditions. This shall be obtained by having transponders operate as local control panels upon loss of network communication.

4. FACP nodes shall be modular in construction to allow ease of servicing. Each CPU and transponder shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems which require use of external programmers or change of EPROMs are not acceptable.

5. The CPU and associated equipment are to be protected so that they will not be affected by voltage surges or line transients including RFI and EMI.

6. Each transponder and peripheral device connected to the FACP node CPU shall be continuously scanned for proper operation. Data transmissions between network nodes, FACP CPUs, transponders, and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equivalent error checking techniques. Failure of any transponder or peripheral device to respond to an interrogation shall be annunciated as a trouble condition.

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

1. Pre-Signal and Positive Alarm Sequence: The system shall provide means to cause pre-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 acknowledge an alarm signal from a fire
detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local remote outputs shall automatically immediately.

2. 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.

   a) 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.

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

3. The system shall be integrated with P.A. System Car Calling system for Emergency evacuation under fire.

4. Each FACP node shall be capable of providing the following features:
   a) Block Acknowledge for Trouble Conditions.
   b) Rate Charger Control
   c) Control-By-Time (Delay, Pulse, time of day, etc.)
   d) Automatic Day/Night Sensitivity Adjust (high/low)
   e) Device Blink Control (turn of detector LED strobe)
   f) Environmental Drift Compensation (selectable ON or OFF)
   g) Smoke Detector Pre-alarm Indication at Control Panel
   h) NFPA 72 Smoke Detector Sensitivity Test
   i) System Status Reports
   j) Alarm Verification, by device, with tally
   k) Multiple Printer Interface
   l) Multiple CRT Display Interface
   m) Non-Fire Alarm Module Reporting
   n) Automatic NFPA 72 Detector Test
o) Programmable Trouble Reminder  

p) Upload/Download System Database to BMS  

q) One-Man Walk Test  

r) Smoke Detector Maintenance Alert  

s) Security Monitor Points  

t) Alpha-numeric Pager Interface  

u) On-line or Off-line programming  

The configuration features & peripherals of FACP shall be given below:

<table>
<thead>
<tr>
<th>Doc1</th>
<th>Standard Data Sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
<td>Floor Fire Alarm Panel</td>
</tr>
<tr>
<td>Purpose</td>
<td>Automatic fire detection and alarm</td>
</tr>
<tr>
<td>Interconnection</td>
<td>Peer to peer networked floor Panels</td>
</tr>
<tr>
<td>Type</td>
<td>Solid state micro-processor based analogue addressable</td>
</tr>
<tr>
<td>Loop capacity</td>
<td>The MNS Panel Should have expandability up to 29 Loops.</td>
</tr>
<tr>
<td></td>
<td>Loop cards as per floor requirement</td>
</tr>
<tr>
<td>Compatibility</td>
<td>Photo electric smoke sensors</td>
</tr>
<tr>
<td></td>
<td>Loop isolators</td>
</tr>
<tr>
<td></td>
<td>Loop sounders</td>
</tr>
<tr>
<td></td>
<td>Loop manual call points</td>
</tr>
<tr>
<td></td>
<td>Loop input monitoring cards</td>
</tr>
<tr>
<td></td>
<td>RS 485 cards for networking &amp; RS 232 cards for printer &amp; CRT</td>
</tr>
<tr>
<td></td>
<td>Convention devices</td>
</tr>
<tr>
<td>No of devices</td>
<td>The Intelligent Signaling Line Circuit (SLC) capable of supporting up to 318 Intelligent Devices 159 analog</td>
</tr>
<tr>
<td><strong>Sensors and 159 addressable modules.</strong></td>
<td></td>
</tr>
<tr>
<td>----------------------------------------</td>
<td></td>
</tr>
<tr>
<td>The system should have the capability to support over 5,000+ points per node.</td>
<td></td>
</tr>
<tr>
<td>The system should have the capability to support over 250,000+ points on a single network.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Operation Voltage</strong></th>
<th>15 V to 28 V DC, 3 amps</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input Voltage</strong></td>
<td>230 V AC, 1 Ph 50HZ, 0.75 amps.</td>
</tr>
<tr>
<td><strong>Standby battery charging</strong></td>
<td>28 V DC, 1.5 A</td>
</tr>
<tr>
<td><strong>Wiring</strong></td>
<td>2 core 1.5 mm(^2), copper, PVC insulated, twisted, screened wires in concealed conduits wherever available &amp; in other places by surface cable for notification loop, sounder loop, RS 232 &amp; RS485 communication</td>
</tr>
<tr>
<td><strong>Loop wire monitoring</strong></td>
<td>Open circuit</td>
</tr>
<tr>
<td></td>
<td>Short circuit</td>
</tr>
<tr>
<td></td>
<td>Earth Leakage</td>
</tr>
<tr>
<td></td>
<td>Device removed</td>
</tr>
<tr>
<td></td>
<td>Wrong Device</td>
</tr>
<tr>
<td><strong>Each Control panel should have In-built BACNET Support.</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Communication</strong></th>
<th>To remote repeater panel through proprietary protocol over RS 485 link</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outputs</strong></td>
<td>2 X programmable sounders on panel</td>
</tr>
<tr>
<td></td>
<td>1 X Fire Contact</td>
</tr>
<tr>
<td></td>
<td>1 X Fault Contact</td>
</tr>
<tr>
<td><strong>Printer</strong></td>
<td>24 character built in printer</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td>RS 485</td>
</tr>
<tr>
<td>Port</td>
<td>RS 232</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Selectable Features</td>
<td></td>
</tr>
<tr>
<td>Common sounders</td>
<td></td>
</tr>
<tr>
<td>coincidence alarm</td>
<td></td>
</tr>
<tr>
<td>RMC Fire</td>
<td></td>
</tr>
<tr>
<td>RMC Fault</td>
<td></td>
</tr>
<tr>
<td>Zone walk test</td>
<td></td>
</tr>
<tr>
<td>Control Output</td>
<td></td>
</tr>
<tr>
<td>Output delay Alarm counter</td>
<td></td>
</tr>
<tr>
<td>Alarm Counter</td>
<td></td>
</tr>
<tr>
<td>Alarm verification</td>
<td></td>
</tr>
<tr>
<td>Sounder silence</td>
<td></td>
</tr>
<tr>
<td>Dialing Time</td>
<td>4 second per loop for devices, 3 second per loop for MCPs</td>
</tr>
<tr>
<td>Software</td>
<td>Firmware</td>
</tr>
<tr>
<td></td>
<td>Field configuration programmable</td>
</tr>
<tr>
<td>Memory</td>
<td>EPROM non volatile for 12000 event memory storage</td>
</tr>
<tr>
<td>Configuration</td>
<td>Power supply module</td>
</tr>
<tr>
<td></td>
<td>CPU</td>
</tr>
<tr>
<td></td>
<td>memory extension module</td>
</tr>
<tr>
<td></td>
<td>memory buffer module</td>
</tr>
<tr>
<td></td>
<td>printer interface module</td>
</tr>
<tr>
<td></td>
<td>LCD interface module</td>
</tr>
<tr>
<td></td>
<td>relay driver module</td>
</tr>
<tr>
<td></td>
<td>The Fire control panel shall have 100% hot redundancy for CPU (or able to work in Degrade Mode).</td>
</tr>
<tr>
<td>Component</td>
<td>Specification</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1 no. menu driven membrane switch keyboard</td>
<td></td>
</tr>
<tr>
<td>1 set control switches</td>
<td></td>
</tr>
<tr>
<td>1 set operator push buttons</td>
<td></td>
</tr>
<tr>
<td>Loop cards</td>
<td></td>
</tr>
<tr>
<td>Remote terminal unit connection port</td>
<td></td>
</tr>
<tr>
<td>LCD display &amp; driver module</td>
<td></td>
</tr>
<tr>
<td>Connectivity</td>
<td>To proprietary protocol compatible to analogue addressable detectors of type</td>
</tr>
<tr>
<td>LCD display</td>
<td>24X40 character alpha numeric LCD auto back-lit with occurrence of event or manual override</td>
</tr>
<tr>
<td>Display Format</td>
<td>Alarm/pre-alarm/fault/isolation</td>
</tr>
<tr>
<td></td>
<td>Alarm &amp; event acknowledge</td>
</tr>
<tr>
<td></td>
<td>Commands/report/programming</td>
</tr>
<tr>
<td></td>
<td>Time/day/date</td>
</tr>
<tr>
<td>Power supply</td>
<td>SMPS</td>
</tr>
<tr>
<td>Back up power supply</td>
<td>As per clause 7.5 of IS 2189</td>
</tr>
<tr>
<td>Power pack</td>
<td>SMF lead acid / Nicd 24 V DC 30 AH</td>
</tr>
<tr>
<td>Test features</td>
<td>Panel self test</td>
</tr>
<tr>
<td></td>
<td>LCD test</td>
</tr>
<tr>
<td></td>
<td>Fault test</td>
</tr>
<tr>
<td></td>
<td>Detector test</td>
</tr>
<tr>
<td></td>
<td>Battery fault</td>
</tr>
<tr>
<td></td>
<td>Internal hooter test</td>
</tr>
<tr>
<td></td>
<td>External hooter test</td>
</tr>
<tr>
<td>Control facility</td>
<td>Scroll/next</td>
</tr>
<tr>
<td></td>
<td>Alarm silence</td>
</tr>
<tr>
<td><strong>Fault silence</strong></td>
<td><strong>Lamp evacuate</strong></td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td><strong>System reset</strong></td>
<td><strong>LCD back Lighting</strong></td>
</tr>
<tr>
<td><strong>Trouble Silence</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Indications**

<table>
<thead>
<tr>
<th><strong>System normal</strong></th>
<th><strong>Priority 1 Alarm</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Priority 2 Alarm</strong></td>
<td><strong>Fault</strong></td>
</tr>
<tr>
<td><strong>Alarm Silence</strong></td>
<td><strong>Power ON</strong></td>
</tr>
<tr>
<td><strong>Battery ON</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Event report**

<table>
<thead>
<tr>
<th><strong>Type</strong></th>
<th><strong>Address</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Location</strong></td>
<td><strong>Time/day/date</strong></td>
</tr>
<tr>
<td><strong>Date</strong></td>
<td><strong>Time</strong></td>
</tr>
</tbody>
</table>

**Zone recording**

| **In order of occurrence regardless of alarm priority** | **Print Interrupt of occurrence of fresh event & on its record resume print** |

**Testing facility**

| **Possible with digital and analogue input and output digital simulation from panel through software** | **Under maintenance mode testing possible with balance system in normal operation** |

**Fire pattern**

<p>| <strong>No alarm issue for short duration</strong> | <strong>Quick response for fast smoke build up</strong> |</p>
<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early detection and suitable modification for alarm level for dirt accumulation</td>
<td></td>
</tr>
<tr>
<td>Programmed output actuation</td>
<td></td>
</tr>
<tr>
<td>Access protection through 4 levels of pass words</td>
<td></td>
</tr>
<tr>
<td>Hardware security lock</td>
<td></td>
</tr>
<tr>
<td>Detector sensitivity adjustment and display of set value</td>
<td></td>
</tr>
<tr>
<td>Disable/isolate detectors/ interface units</td>
<td></td>
</tr>
<tr>
<td>Single button operation front panels keys</td>
<td></td>
</tr>
<tr>
<td>Software facility</td>
<td>Individual detector</td>
</tr>
<tr>
<td>Sensitivity setting</td>
<td></td>
</tr>
<tr>
<td>Trending</td>
<td></td>
</tr>
<tr>
<td>Adjustable dual alarm thresholds</td>
<td></td>
</tr>
<tr>
<td>Pre alert warning</td>
<td></td>
</tr>
<tr>
<td>Cross zoning</td>
<td></td>
</tr>
<tr>
<td>Alarm verifications</td>
<td></td>
</tr>
<tr>
<td>Input/ output assignment</td>
<td></td>
</tr>
<tr>
<td>Event history indexing</td>
<td></td>
</tr>
<tr>
<td>Local Sounder</td>
<td>Yes</td>
</tr>
<tr>
<td>Panel Sounder output</td>
<td>1 no. rated for 1 Amp.</td>
</tr>
<tr>
<td>Surge withstand</td>
<td>As per IEEE 472 for mains, input/ output/loops, 7 kv discharge on panel electronics except LCD display</td>
</tr>
<tr>
<td>Ambient</td>
<td>From (-) 5 deg. C to (+) 45 deg C Max.</td>
</tr>
<tr>
<td>Humidity</td>
<td>15% to 95% non condensing</td>
</tr>
<tr>
<td>Mounting</td>
<td>Wall / floor</td>
</tr>
<tr>
<td>Enclosure</td>
<td>1.6mm sheet steel, dust and vermin proof to IP 55</td>
</tr>
<tr>
<td>Enclosure treatment &amp; painting</td>
<td>Degreased, de-rusted, pickled, rinsed, phosphattized, putty finished. Double primer and final epoxy painted FIRE RED shade</td>
</tr>
<tr>
<td>------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Front doors</td>
<td>Hinged and lockable with transparent visor for viewing LEDs etc.</td>
</tr>
<tr>
<td>Cable Entry</td>
<td>From both top &amp; bottom, through 2 mm thick removable gland plate</td>
</tr>
</tbody>
</table>

- **Network Repeater Panel (NRP)**

A network control annunciator shall be provided to display all system intelligent points. The NRP shall be capable of displaying all information for all 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 940(24X40) characters, backlit by a long life, solid state LCD display. It shall also include a keypad. 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 back box designed for this use.

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.

For time keeping purposes the NRP shall include a time of day clock.
The configuration, features & peripherals of the Repeater panel shall be given below:

<table>
<thead>
<tr>
<th>Doc 2</th>
<th>STANDARD DATA SHEET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
<td>Network Repeater Panel</td>
</tr>
<tr>
<td>Purpose</td>
<td>Repeat indication</td>
</tr>
<tr>
<td>Compatibility</td>
<td>With networked analogue addressable floor fire alarm panel through proprietary communication protocol</td>
</tr>
<tr>
<td>Type</td>
<td>Solid state micro-processor based</td>
</tr>
<tr>
<td>Communication</td>
<td>By 2 core RS 485 twisted pair screened with networked floor fire alarm analogue addressable panels</td>
</tr>
<tr>
<td>Distance maximum</td>
<td>Up to 2 Km from nearest networked floor addressable fire alarm panel. Connection to system by tee off / spur / daisy chained</td>
</tr>
<tr>
<td>Power Supply</td>
<td>From power supply unit or from nearest floor addressable fire alarm panel.</td>
</tr>
<tr>
<td>Operating Voltage</td>
<td>15 V to 28 V DC</td>
</tr>
<tr>
<td>Monitoring</td>
<td>Panel power disconnection</td>
</tr>
<tr>
<td></td>
<td>Floor / Loop / Zone indication LEDs (50 nos)</td>
</tr>
<tr>
<td></td>
<td>Select keys for point addresses in display zone</td>
</tr>
<tr>
<td></td>
<td>Fire</td>
</tr>
<tr>
<td></td>
<td>Fault</td>
</tr>
<tr>
<td></td>
<td>Disabled</td>
</tr>
<tr>
<td></td>
<td>Accept / Reset / Silence / Sound alarm</td>
</tr>
<tr>
<td></td>
<td>Control key for current Fire / Fault / Disabled status</td>
</tr>
<tr>
<td>Power consumption</td>
<td>100 mA mains fail state</td>
</tr>
<tr>
<td></td>
<td>250 mA nominal</td>
</tr>
<tr>
<td></td>
<td>350 mA max. draw</td>
</tr>
</tbody>
</table>
### LCD display
- Back lit, Alphanumeric, 24X40 character display

### Data interface
- RS 485 serial bus driver board

### Mounting
- Suitable for both surface & recess mounting

### Enclosure
- 1.8 mm sheet steel, dust and vermin proof
- Hinged lockable double door

### Ambient
- From (-) 5\(^\circ\)C to (+) 45\(^\circ\)C Max

### Humidity
- 15 % to 95 % non condensing

### Paint
- Degreased, de-rusted, pickled, rinsed, phosphatized epoxy painted in FIRE RED paint

### Local sounder
- Yes

#### Water flow Indicators:

Water flow Switches shall be an integral, mechanical, non-coded, non-accumulative retard type.

Water flow Switches shall have an alarm transmission delay time, which is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds.

All water flow switches shall come from a single manufacturer and series.

Water flow switches shall be provided and connected under this section but installed by the mechanical contractor.

Where possible, locate water flow switches a minimum of one (1) foot from a fitting, which changes the direction of the flow and a minimum of three (3) feet from a valve.

#### Sprinkler and Standpipe Valve Supervisory Switches:

Each sprinkler system water supply control valve riser, zone control valve, and standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.

PIV (post indicator valve) or main gate valves shall be equipped with a supervisory switch.

The switch shall be mounted so as not to interfere with the normal operation of the valve and adjusted to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position.
The supervisory switch shall be contained in a weatherproof aluminum housing, which shall provide a 25 mm conduit entrance and incorporate the necessary facilities for attachment to the valves.

The switch housing shall be finished in red baked enamel.

The entire installed assembly shall be tamper proof and arranged to cause a switch operation if the housing cover is removed, or if the unit is removed from its mounting.

Valve supervisory switches shall be provided and connected under this section and installed by mechanical contractor.

- **Non-Alarm Input Operation**

Any addressable initiating device in the system may be used as a non-alarm input to monitor normally open contact type devices. Non-alarm functions are a lower priority than fire alarm initiating devices.

Combo Zone: - A special type code shall be available to allow water flow and supervisory devices to share a common addressable module. Water flow devices shall be wired in parallel, supervisory devices in series.

- **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 from 001 to the maximum address provided by SLC loop.

Addressable devices, which use a binary address setting method, such as a Dip switch, are not an allowable substitute.

Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the FACP Signaling line circuit.

Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash 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 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. Sensitivity shall be automatically adjusted by the panel on a time-of-day basis.
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 or EN 54.

The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base shall include a sounder base with a built-in (local) sounder rated at 85 DB minimum, a relay base and an isolator base designed for Class A 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 (Photoelectric, Thermal& Photo-thermal).

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

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.

- **Programmable Electronic Exit Point Directional Sounders**

  Electronic sounders shall operate on 24 VDC nominal. Electronic sounders shall be field programmable without the use of special tools, at a sound level of at least 90 dBA measured at 10 feet from the device. It shall be capable to broadcast preprogrammed Voice Message also and shall be flush or surface mounted as shown on plans. It shall produce broad-band directional sound to guide occupants to safe exists even in complete darkness.

  Strobe lights shall meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria: The maximum pulse duration shall be 2/10 of one second.

  Strobe intensity shall meet the requirements of UL 1971.

  The flash rate shall meet the requirements of UL 1971.

- **Addressable Pull Box (manual station)**

  Addressable pull 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 stations 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 or larger.

- **Intelligent Multi-Co-Operative Sensing Photoelectric Smoke Detector (As required)**

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.

Photo-electric Fire Alarm detector having photo electric smoke sensor and thermal sensor incorporated and shall send individual smoke sensitivity and temperature operation to panel having following technical specifications:

- Operating Temperature: 0 to 50°C
- Humidity: 10 to 95%
- Smoke sensor sensitivity: 0.2% to 3.7% per foot of smoke Obstruction
- Smoke sensor Air velocity: 0-610 m/min

- **Intelligent Thermal Detectors (As required)**

Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a fixed rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.

- **Intelligent Multi Criteria (Photo- Thermal) Acclimating Detector**

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 its 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.

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).

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.

The detector shall have Isolator modules 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 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 campus.

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.

- **Two-Wire Detector Monitor Module**

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

  The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

  For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch x 1-1/4 inch x 1/2 inch. This version need not include Style D or an LED.

- **Addressable Control Module**

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

  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, or as a dry contact (Form-C) relay. 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.
Audio/visual power shall be provided by a separate supervised power loop from the main fire alarm control panel or from a supervised, UL listed remote power supply.

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

- **Addressable Relay Module**

Addressable Relay Modules shall be available for HVAC (AHUs & Ventilation Fans) 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.

- **EXECUTION**

- **INSTALLATION:**

  a. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

  b. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

  c. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

  d. Manual Pull Stations shall be suitable for surface mounting or semi flush mounting as shown on the plans, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor.

  e. Manual Pull Station of Metal Die cast body & meeting requirments of UL 38, Para No 3.2.1 & NFPA-72, Para No-17.4.2.

- **TYPICAL OPERATION:**

  - Actuation of any manual station, smoke detector, heat detector or water flow switch shall cause the following operations to occur unless otherwise specified:

  - Activate all programmed speaker circuits.
• Actuate hooter units until the panel is reset.

• Light the associated indicators corresponding to active speaker circuits.

• Release all magnetic door holders to doors to adjacent zones on the floor from which the alarm was initiated.

• Where required, return all elevators to the primary or alternate floor of egress.

• A smoke detector in any elevator lobby shall, in addition to the above functions, return all elevators to the primary or alternate floor of egress.

• Smoke detectors in the elevator machine room or top of hoistway shall return all elevators in to the primary or alternate floor. Smoke detectors or heat detectors installed to shut down elevator power shall do so in accordance with ANSI A17.1 requirements and be coordinated with the electrical contractor.

• Duct type smoke detectors shall, in addition to the above functions, shut down the ventilation system or close associated control dampers as appropriate.

• Activation of any sprinkler system low-pressure switch, on valve tamper switch, shall cause a system supervisory alarm indication.

• **HVAC/Smoke Control System Operation:**

  • On/Auto/Off switches and status indicators (LEDS) shall be provided for monitoring and manual control of each fan, damper, HVAC control unit, stairwell pressurization fan, and smoke exhaust fan.

  • The OFF LED shall be Yellow, the ON LED shall be green, and the Trouble/Fault LED shall be Amber/Orange for each switch. The Trouble/Fault indicator shall indicate a trouble in the control and/or monitor points associated with that switch. In addition, each group of eight switches shall have two LEDS and one momentary switch which allow the following functions: An Amber LED to indicate an OFF-NORMAL switch position, in the ON or OFF position; A Green LED to indicate ALL AUTO switch position; A Local Acknowledge/Lamp Test momentary switch.

  • Each switch shall have the capability to monitor and control two addressable inputs and two addressable outputs. In all modes, the ON and OFF indicators shall continuously follow the device status not the switch position. Positive feedback shall be employed to verify correct operation of the device being controlled. Systems that indicate on/off/auto by physical switch position only are not acceptable.

  • All HVAC switches (i.e., limit switches, vane switches, etc.) which shall be provided and installed by the HVAC contractor, but the detail of the
switches required shall be provided by the vendor for fire alarm system as per the equipment layout in the building.

- It shall be possible to meet the requirements mentioned above utilizing wall mounted custom graphic annunciators if the project requires such.

**TEST**

The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system.

a. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.

b. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.

c. Verify activation of all flow switches.

d. Open initiating device circuits and verify that the trouble signal actuates.

e. Open signaling line circuits and verify that the trouble signal actuates.

f. Open and short notification appliance circuits and verify that trouble signal actuates.

g. Open and short (wire only) network communications and verify that trouble signals are received at network annunciators or reporting terminals.

h. Ground initiating device circuits and verify response of trouble signals.

i. Ground signaling line circuits and verify response of trouble signals.

j. Ground notification appliance circuits and verifies response of trouble signals.

k. Check alert tone and prerecorded voice message to all alarm notification devices.

l. Check installation, supervision & operation of all intelligent smoke detectors using walk test.

m. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.

n. When the system is equipped with optional features, the manufacturer's manual should be consulted to determine the proper testing procedures.
This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

- **FINAL INSPECTION:**

  At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

- **INSTRUCTION & SEQUENCE OF OPERATION:**

  Instruction shall be required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided. The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."
CHAPTER - 12

TECHNICAL SPECIFICATIONS FOR CLOSED CIRCUIT TELEVISION SYSTEM, PUBLIC ADDRESS SYSTEM AND ACCESS CONTROL SYSTEM

- **CCTV & SURVEILLANCE SYSTEM**

The Entire surveillance system is proposed and designed to control and monitors the different area. All the buildings shall have IP Based Dome/Bullet Camera indoor type and PTZ Cameras for outdoor surveillance. The different types of cameras shall be provided at locations as mentioned in Design Basis Report.

The indoor Dome Cameras and Bullet Cameras are proposed to be installed at all Entry & Exit Points in Ground floor. And in other Floors these cameras will be fixed in corridors, Lift Lobby & staircase entrances.

All the outdoor cameras shall be in IP 66 Housing and Junction box, power supply unit, media converter etc are proposed in dust proof housing The existing LAN network switches would be used for CCTV connectivity and will be connected to central CCTV server & cameras shall have POE connectivity ports. The power supply to LAN switches will be on UPS. The video recording shall be non embedded based recording server of reputed make with video management software.

Control Room shall be located in the Admin block in the Security /Control Room. The wiring inside the building shall be with CAT 6 cable in PVC conduit and Armoured fiber Optic Cable and Outdoor connectivity shall be under ground in HDPE pipes with suitable Manholes for proper Maintenance of the system. PTZ cameras will be placed on roof top and Street light Poles in external areas. The video management server should have minimum 30 days storing capacity.

- **CAMERA SPECIFICATIONS**

1. **ONVIF Conformant, UL Listed Day/Night True IP Full HD Infrared Dome Camera**

<table>
<thead>
<tr>
<th>S.N O.</th>
<th>Camera Characteristics</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Requirement Overview</td>
<td>The camera shall capable of resolutions up to 2560x1920 @ 30 fPS while optimizing network usage with either H.264, H.265 or MJPEG compression.</td>
</tr>
<tr>
<td></td>
<td>Sensor Type</td>
<td>1/2.7-inch CMOS</td>
</tr>
<tr>
<td>---</td>
<td>---------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>3</td>
<td>Total sensor pixels</td>
<td>1952 x 1092 (2MP)</td>
</tr>
<tr>
<td>4</td>
<td>Dynamic Range</td>
<td>100 dB or Better</td>
</tr>
<tr>
<td>5</td>
<td>Lens/Iris</td>
<td>Varifocal 3 to 10 mm, DC Iris F1.5 – 360, IR corrected</td>
</tr>
<tr>
<td>6</td>
<td>Minimum illumination</td>
<td>Color mode: 0.04 lux @ F 1.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Black-and-white mode: .001@ f 1.3</td>
</tr>
<tr>
<td>7</td>
<td>Field of View</td>
<td>36° - 117° (horizontal) 20° - 61° (vertical)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>64° to 113° (diagonal)</td>
</tr>
<tr>
<td>8</td>
<td>Privacy regions</td>
<td>The camera supports up to five user-defined privacy regions. Any video within a privacy region is masked in the video stream.</td>
</tr>
<tr>
<td>9</td>
<td>Digital I/O</td>
<td>Digital in x 1 &amp; Digital out x1</td>
</tr>
<tr>
<td>10</td>
<td>Audio I/O</td>
<td>Built-in microphone (can be permanently disabled)</td>
</tr>
<tr>
<td>11</td>
<td>Number of streams</td>
<td>Should support at least 3 or more streams simultaneously</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Should support H.265, H.264, or MJPEG video streams simultaneously</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Each Video streams can be configured with Individual resolution, quality and frame rate setting</td>
</tr>
<tr>
<td>12</td>
<td>Day/Night</td>
<td>The cameras provide true day/night functionality, and include an infrared (IR) filter that automatically switches to night mode in low-light scenes. This should be setup Automatic, manual, scheduled.</td>
</tr>
<tr>
<td>No.</td>
<td>Description</td>
<td>Specification</td>
</tr>
<tr>
<td>-----</td>
<td>------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>13</td>
<td>Local Storage</td>
<td>Supports up to 32 GB microSDHC &amp; 2 TB microSDXC card.</td>
</tr>
<tr>
<td>14</td>
<td>Video Compression</td>
<td>H.264 &amp; Motion JPEG and H.265 (Smart Stream)</td>
</tr>
<tr>
<td>15</td>
<td>Open API</td>
<td>ONVIF &amp; profile G &amp; S for standard based interoperability</td>
</tr>
<tr>
<td>16</td>
<td>Shutter speed</td>
<td>1/5 sec. to 1/32,000 sec</td>
</tr>
</tbody>
</table>
| 18  | Camera Tamper                | The camera should support tamper feature when any of the following events occur and persist for a designated period:  
- The IP camera view is changed  
- The IP camera view is blocked  
- The IP camera view is substantially out of focus |
| 19  | Quality of service (QoS)     | Differentiated services code point (DSCP) marking and class of service (CoS) marking |
| 20  | Software                     |                                                                              |
|     | Unit Configuration           | Via web browser or **Configuration Manager**                                  |
|     | Firmware update              | Remotely programmable                                                         |
|     | Software viewer              | Web browser, **Video Security Client**, or third party software               |
|     | Video Analysis               | **MOTION+**                                                                   |
2. ONVIF Conformant, UL Listed Day/Night True IP Full HD Infrared 5MP,30FPS Bullet Camera

<table>
<thead>
<tr>
<th>S.N O.</th>
<th>Camera Characteristic s</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Requirement Overview</td>
<td>The camera shall capable of resolutions up to 2592x1944 @ 30 fps while optimizing network usage with either H.264, H.265 or MJPEG compression.</td>
</tr>
<tr>
<td>2</td>
<td>Sensor Type</td>
<td>1/2.9-inch CMOS</td>
</tr>
<tr>
<td>3</td>
<td>Max Resolution</td>
<td>2592x1944@ 30 fps &amp; 1080x1920@60fps with H.264/H.265 2560x1920 @ 12 fps and 1080x1920@30fps with MJPEG</td>
</tr>
<tr>
<td>4</td>
<td>Dynamic Range</td>
<td>100 dB or Better</td>
</tr>
<tr>
<td>5</td>
<td>Lens/Iris</td>
<td>Varifocal 2.8 to 12 mm, DC Iris F1.3 - 360</td>
</tr>
<tr>
<td>6</td>
<td>Minimum illumination</td>
<td>Color mode: 0.04 lux @ F 1.3  Black-and-white mode: .001@ f 1.3</td>
</tr>
<tr>
<td>7</td>
<td>Field of View</td>
<td>45° to 84° (horizontal) 34° to 62° (vertical) 64° to 113° (diagonal)</td>
</tr>
<tr>
<td>8</td>
<td>Privacy</td>
<td>The camera supports up to five user-defined privacy regions. Any video within a privacy region is masked in the</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>9</td>
<td>Digital I/O</td>
<td>Digital in x 1 &amp; Digital out x1</td>
</tr>
<tr>
<td>10</td>
<td>Audio Communication</td>
<td>Two-way, full duplex</td>
</tr>
<tr>
<td>11</td>
<td>Number of streams</td>
<td>Should support at least 3 or more streams simultaneously&lt;br&gt;Should support H.265, H.264, or MJPEG video streams simultaneously&lt;br&gt;Each Video streams can be configured with Individual resolution, quality and frame rate setting</td>
</tr>
<tr>
<td>12</td>
<td>Day/Night</td>
<td>The cameras provide true day/night functionality, and include an infrared (IR) up to 60 meter filter that automatically switches to night mode in low-light scenes. This should be setup Automatic, manual, scheduled.</td>
</tr>
<tr>
<td>13</td>
<td>Local Storage</td>
<td>Micro SD</td>
</tr>
<tr>
<td>14</td>
<td>Video Compression</td>
<td>H.264 &amp; Motion JPEG and H.265 (Smart Stream)</td>
</tr>
<tr>
<td>15</td>
<td>Open API</td>
<td>ONVIF &amp; profile G&amp;S for standard based interoperability</td>
</tr>
<tr>
<td>16</td>
<td>Shutter speed</td>
<td>Fixed (1/30 [1/25] to 1/15000)</td>
</tr>
<tr>
<td>18</td>
<td>Camera Tamper</td>
<td>The camera should support tamper feature when any of the following events occur and persist for a designated period: &lt;br&gt;• The IP camera view is changed&lt;br&gt;• The IP camera view is blocked&lt;br&gt;• The IP camera view is substantially out of focus</td>
</tr>
<tr>
<td>19</td>
<td>Quality of Differentiated services code point (DSCP) marking and class</td>
<td></td>
</tr>
</tbody>
</table>
3. **ONVIF Conformat, UL Listed Day/Night, IR 30X , IP 66 HD PTZ Outdoor Camera**

<table>
<thead>
<tr>
<th>S. N</th>
<th>Camera Characteristics</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Image Sensor</td>
<td>The camera shall provide a 1/2.8-in. type progressive scan CMOS</td>
</tr>
<tr>
<td></td>
<td>Maximum Resolution</td>
<td>1920x1080 (2.1MP) The camera shall offer 1080p60fps resolution for capturing fast motion.</td>
</tr>
<tr>
<td></td>
<td>Lens type</td>
<td>30x Optical Zoom, Auto Focus, Digital Zoom 16X</td>
</tr>
<tr>
<td></td>
<td>Focal length</td>
<td>4.5 mm - 135 mm (F 1.6 - F 4.4)</td>
</tr>
<tr>
<td></td>
<td>Auto-iris</td>
<td>DC- iris</td>
</tr>
<tr>
<td></td>
<td>Day/Night</td>
<td>Removable IR-cut filter for day &amp; night function, 180 m (590 feet) (Detection) either integrated or external</td>
</tr>
<tr>
<td></td>
<td>WDR Technology</td>
<td>WDR Pro, True WDR or Better, 80DB</td>
</tr>
<tr>
<td></td>
<td>Field of View</td>
<td>2.4° - 60.9°</td>
</tr>
<tr>
<td>Specification</td>
<td>Details</td>
<td></td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Pan Speed</td>
<td>Pan: 240°/s,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pan Range</td>
<td>360°</td>
<td></td>
</tr>
<tr>
<td>Tilt Speed</td>
<td>Tilt: 160°/s</td>
<td></td>
</tr>
<tr>
<td>Tilt Range</td>
<td>220° (-110° ~ +110°)</td>
<td></td>
</tr>
<tr>
<td>Video Compression</td>
<td>H.264, H.265 &amp; MJPEG</td>
<td></td>
</tr>
<tr>
<td>Maximum frame rate</td>
<td>30 fps @ 1920x1080 in all compression mode</td>
<td></td>
</tr>
<tr>
<td>Local Storage</td>
<td>microSDHC or microSDXC memory card (Minimum 256 GB)</td>
<td></td>
</tr>
<tr>
<td>Maximum Stream</td>
<td>Four simultaneously Streams</td>
<td></td>
</tr>
<tr>
<td>Audi Capability and Compression</td>
<td>Full duplex Audio and G.711, G.726 Compression codecs</td>
<td></td>
</tr>
<tr>
<td>ONVIF</td>
<td>Should support for ONVIF 2.0 allows for standards based interoperability</td>
<td></td>
</tr>
<tr>
<td>Motion Detection</td>
<td>Five-window video motion detection</td>
<td></td>
</tr>
<tr>
<td>Auto Tracking</td>
<td>Auto-tracking on moving object</td>
<td></td>
</tr>
<tr>
<td>Casing</td>
<td>IP66, IK10, NEMA 4X</td>
<td></td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-40 to 50°C</td>
<td></td>
</tr>
<tr>
<td>Certifications Safety and Certifications EMC-requirements</td>
<td>CE, FCC Class A, NEMA 4X</td>
<td></td>
</tr>
<tr>
<td>PTZ Auto Tracking</td>
<td>The PTZ IP camera should automatically track an object that is larger than a configured threshold. When tracking, the IP camera uses its pan and tilt features to</td>
<td></td>
</tr>
</tbody>
</table>
4. **ONVIF Video Management Software**

<table>
<thead>
<tr>
<th>S.N O.</th>
<th>Characteristics and Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>General Video Management System requirement</td>
</tr>
</tbody>
</table>

The video management system (VMS) specified is an enterprise-class client/server based IP video security solution that provides seamless management of digital video, audio and data across an IP network. The video management system is designed to work with ONVIF compliant 3rd party products as part of a total video security management system to provide full virtual matrix switching and control capability. The video management system consists of the following software modules: management server, recording services, configuration client and operator clients. Video from other sites may be viewed from single or numerous workstations simultaneously at any time. Cameras, recorders, and viewing stations may be placed anywhere in the IP network.
<table>
<thead>
<tr>
<th>S.N O.</th>
<th>Characteristics and Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td><strong>VMS shall include, as a minimum, the following features/ functions/ specifications;</strong></td>
</tr>
<tr>
<td>3</td>
<td>The surveillance system shall provide a scalable and reliable platform to enable customized, network-based surveillance applications.</td>
</tr>
<tr>
<td>4</td>
<td>The system shall support digital pan-tilt-zoom on live video. PTZ cameras should allow operators to use PTZ controls to zoom to a specific region in the viewing pane. Operators should select part of the full image and perform the PTZ controls within that region.</td>
</tr>
<tr>
<td>5</td>
<td>The surveillance system viewing system should be thin client through http browser for local/remote viewing. VMS shall provide the capability of viewing single or multiple live and archive cameras, and control of PTZ camera.</td>
</tr>
<tr>
<td>6</td>
<td>VMS should support mobile application for Android &amp; Apple devices such as the iPad and iPhone. App features should include recorded video playback, thumbnail video preview, and user profiles that allow multiple users to share a single device.</td>
</tr>
<tr>
<td>7</td>
<td>VMS system should highly scalable and shall be expandable up to 10,000 cameras.</td>
</tr>
<tr>
<td>8</td>
<td>The video management system shall support both appliance &amp; virtual machine based deployment</td>
</tr>
<tr>
<td>9</td>
<td>Video Surveillance Storage System – The video surveillance storage system should support multiple options to store video. Servers, Direct Attached, shall augment server internal storage. The video surveillance storage system shall store video in loops, one-time archives, or event clips triggered by alarm systems.</td>
</tr>
<tr>
<td>10</td>
<td>The system shall provide for integration with other software applications through an open and published Application Programming Interface (API). Such applications shall include, but not be limited to, access control, video analytics, and other alarm and sensor inputs.</td>
</tr>
<tr>
<td>11</td>
<td>The system should ensure that once recorded, the video cannot be altered; ensuring the audit trail is intact for evidential purposes.</td>
</tr>
<tr>
<td>S.N O.</td>
<td>Characteristics and Description</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>12</td>
<td>All camera recordings shall have camera ID and location or area of recording and shall be programmable by the system administrator with user ID and password.</td>
</tr>
<tr>
<td>13</td>
<td>System shall support camera template to define the resolution, frame rate, recording duration, and then apply to a group of cameras. The modification of the template will be reflected to all the cameras under the template.</td>
</tr>
<tr>
<td>14</td>
<td>The system shall support Bul Action to allow to search and perform administration activities on multiple camera.</td>
</tr>
<tr>
<td>15</td>
<td>System shall support Bulk import of cameras from file such as excel/.csv, or other standard file format. The files shall include camera name, IP address, server, template, location, camera username and password.</td>
</tr>
<tr>
<td>16</td>
<td>The System should support LDAP (Lightweight Directory Access Protocol) server.</td>
</tr>
<tr>
<td>17</td>
<td>Shall have Advanced map system with ability to position cameras and floor plans by GIS coordinates.</td>
</tr>
</tbody>
</table>

**VMS Server Management Console**

| 18    | VMS server management console shall provide the initial server Setup Wizard, monitor system logs and resources, and troubleshoot hardware and system software issues, and gather information about the installed hardware and software components. |
| 20    | The VMS Server Management Console user interface shall available for each instance of system software installed on either a physical server or as a virtual machine. |
| 21    | VMS Server Management systems should support network time protocol (NTP) on server, which automatically sets the server time and date. |

**VMS Operations & Management Console**

<p>| 22    | The VMS Operations Management Console should have browser-based configuration and administration tool used to manage the devices, video streams, archives, and policies for Video Management System deployment. |</p>
<table>
<thead>
<tr>
<th>S.N O.</th>
<th>Characteristics and Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>VSM operation and management system should support the following feature:</td>
</tr>
<tr>
<td>24</td>
<td>Manage physical devices - Add, configure and monitor the cameras and servers that provide live and recorded video.</td>
</tr>
<tr>
<td>25</td>
<td>Manage server services - Configure, enable or disable server services, such as the recording servers that manage video playback and recording.</td>
</tr>
<tr>
<td>26</td>
<td>Monitor video - View live and recorded video, save video clips, search thumbnail summaries of recorded video, use the camera, Pan, Tilt and Zoom (PTZ) controls, or configure pre-defined video Views and Video Walls.</td>
</tr>
<tr>
<td>28</td>
<td>Define recording and event policies - Create recording schedules, define event-triggered actions, configure motion detection, and other features.</td>
</tr>
<tr>
<td>29</td>
<td>Monitor system and device health - View a summary of system health for all devices, or device status, alerts and events.</td>
</tr>
</tbody>
</table>

**VMS Monitoring Console**

| 30    | VMS monitoring Console application should allow VMS System users to monitor live and recorded video. |
| 31    | VMS monitoring Console should support below viewing tools & features; |
| 32    | **I. Desktop Monitoring application** |
|       | Shall support for viewing the monitoring at minimum 5 different places in the complex. |
| 33    | shall support simultaneous viewing of up to 25 cameras per workspace/workstation. |
| 34    | Create Video Matrix windows for display in separate monitors. |
| 34    | Create unattended workstations. |
| 35    | View and manage alerts. |
| 36    | View cameras, video, and alerts based on a graphical map |
| 36    | **II. Web-based configuration and monitoring tool** |
### Characteristics and Description

<table>
<thead>
<tr>
<th>S.N O.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>37</td>
<td>Allows simultaneous viewing of multiple video panes, View up to 25 cameras with the 64-bit version of Internet Explorer.</td>
</tr>
<tr>
<td>38</td>
<td>Configure the camera, streams and recording schedules</td>
</tr>
</tbody>
</table>

### III. Web Based Server Console

39. Should provide basic viewing features for a single stream (Stream A) from a single camera

**Analytic features: Shall support following Analytics Feature**

40. Clip Management—Use Clip Management to view, download and delete MP4 clips that are stored on the server

41. Motion detection and Analysis—Use Motion Analysis to view a summary of motion events for recorded video.

42. Thumbnail Search—Use the Forensic Search feature to create thumbnail images from a video archive. Use the thumbnails to locate specific scenes or events in the archive, then play the video in the Operator window or save it to a drive

43. Edge Video Analytic: Surveillance solution should support the Edge video analytic capability that should enable camera to trigger events when it detects activities or behaviors that match predefined rules. Should support following Analytic features on cameras

   43.1 Activity—Detects moving objects within an area that is configured in the camera view

   43.2 Line Crossing—Detects moving objects that cross a line that is configured in the camera view

   43.3 Object Taken—Detects a marked object in the camera view being removed from its location

   43.4 Zone Intrusion—Detects objects that enter an area that is configured in the camera view

   43.5 Wrong Way—Detects objects that are moving in the direction of an arrow that
is configured in the camera view

<table>
<thead>
<tr>
<th>S.N O.</th>
<th>Characteristics and Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>VMS software &amp; recording &amp; Management server should be from same OEM</td>
</tr>
<tr>
<td>45</td>
<td>All the software &amp; hardware should be provided with 3 year support</td>
</tr>
</tbody>
</table>

**Specifications of Central Core Server for Surveillance Operation & Management Application at DC**

<table>
<thead>
<tr>
<th>S.N O.</th>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Form factor</td>
<td>Management server should be an enterprise-class server in a 1RU form factor</td>
</tr>
<tr>
<td>2</td>
<td>CPU</td>
<td>Should have Intel Xeon processor (Preferably E5-2600 family) with atleast 2.3GHz speed &amp; with 6-core CPU</td>
</tr>
<tr>
<td>3</td>
<td>SAS drive</td>
<td>Should support atleast 4 Number of Hot-swappable SAS drive and Server should be populated as per solution need</td>
</tr>
<tr>
<td>4</td>
<td>Integrated Ethernet Port</td>
<td>Dual Gigabit Ethernet Port</td>
</tr>
<tr>
<td>5</td>
<td>USB Port</td>
<td>2 ports (USB 3.0)</td>
</tr>
<tr>
<td>6</td>
<td>Video Ports</td>
<td>1 VGA video port</td>
</tr>
<tr>
<td>7</td>
<td>RAID Controller</td>
<td>Should have RAID controller card</td>
</tr>
<tr>
<td>8</td>
<td>Fans &amp; Power supply</td>
<td>Dual-redundant fans and hot-swappable, redundant power supplies</td>
</tr>
<tr>
<td>9</td>
<td>Memory</td>
<td>Should have atleast 16GB DDR4 RAM</td>
</tr>
</tbody>
</table>
## 5. Recording or Media Server Specification for Data Center

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Form factor</td>
<td>Recording server should be an enterprise-class server in a 2RU form factor</td>
</tr>
<tr>
<td>2</td>
<td>CPU</td>
<td>Should have dual Intel Xeon processor (Preferably E5-2600 family) with atleast 2.3GHz speed &amp; with 6-core each CPU</td>
</tr>
<tr>
<td>3</td>
<td>SAS drive</td>
<td>Should support atleast 12 Number of Hot-swappable SAS drive and Server should be populated with 8*10TB HDD to record the video.</td>
</tr>
<tr>
<td>4</td>
<td>Integrated Ethernet Port</td>
<td>Dual Gigabit Ethernet Port</td>
</tr>
<tr>
<td>5</td>
<td>USB Port</td>
<td>2 ports (USB 3.0)</td>
</tr>
<tr>
<td>6</td>
<td>Video Ports</td>
<td>1 VGA video port</td>
</tr>
<tr>
<td>7</td>
<td>RAID Controller</td>
<td>Should have RAID controller card</td>
</tr>
<tr>
<td>8</td>
<td>Fans &amp; Power supply</td>
<td>Dual-redundant fans and hot-swappable, redundant power supplies</td>
</tr>
<tr>
<td>9</td>
<td>Memory</td>
<td>Should have atleast 16GB DDR4 RAM</td>
</tr>
<tr>
<td>10</td>
<td>Recording/VMS licenses</td>
<td>Server should be supplied with VSM licenses</td>
</tr>
</tbody>
</table>

## 6. 54" Full HD LED Display Monitor.
<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Display:</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Screen Size:</td>
<td>54&quot; (Diagonal)</td>
</tr>
<tr>
<td>3</td>
<td>Panel:</td>
<td>DIRECT LED</td>
</tr>
<tr>
<td>4</td>
<td>Resolution (HxV):</td>
<td>1920 x 1080 pixels</td>
</tr>
<tr>
<td>5</td>
<td>Brightness:</td>
<td>800 cd/m²</td>
</tr>
<tr>
<td>6</td>
<td>Viewing Angle:</td>
<td>178 degrees</td>
</tr>
<tr>
<td>7</td>
<td>CONNECTION TERMINAL:</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>VIDEO IN:</td>
<td>BNC x 1</td>
</tr>
<tr>
<td>9</td>
<td>AUDIO IN (L/R):</td>
<td>RCA x 1 set</td>
</tr>
<tr>
<td>10</td>
<td>COMPONENT/RGB IN:</td>
<td>1 set (BNC x3)</td>
</tr>
<tr>
<td>11</td>
<td>HDMI IN:</td>
<td>HDMI x 1</td>
</tr>
<tr>
<td>12</td>
<td>DVI-D IN/Out:</td>
<td>24pin x 1/24pin x 1</td>
</tr>
<tr>
<td>13</td>
<td>PC IN:</td>
<td>MINI D-SUB 15PIN x1 (Female)</td>
</tr>
<tr>
<td>14</td>
<td>AUDIO IN:</td>
<td>M3 jack x 1</td>
</tr>
<tr>
<td>15</td>
<td>Speaker Out:</td>
<td>External Speaker Jack (Side), 20W (10W x 10W)</td>
</tr>
<tr>
<td>16</td>
<td>Line Out:</td>
<td>RCA Pin (L/R) x1 (Side)</td>
</tr>
<tr>
<td>17</td>
<td>CONTROL TERMINAL:</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>LAN:</td>
<td>RJ45 x 1 (Web Browser Control)</td>
</tr>
<tr>
<td>19</td>
<td>SERIAL Port:</td>
<td>D-SUB 9 pin x 1 (SERIAL IN/Out) RS-232C Compatible</td>
</tr>
<tr>
<td>20</td>
<td>IR IN/OUT:</td>
<td>M3 Jack x 1/x 1</td>
</tr>
</tbody>
</table>
### Sr.No | Parameter | Specification
--- | --- | ---
21 | ELECTRICAL: |  
22 | Power Requirements: | 110-127 V AC, 50Hz/60Hz, 120 V AC 50/60Hz  
23 | | 220-240 V AC, 50/60Hz  
24 | Power Consumption: | Less than 320 W  
25 | MECHANICAL: |  
26 | Display only (WXHxD): | 47.9” X 27.1” X 4.8”  
27 | | (1216 mm X 687 mm X 122 mm)  
28 | Temperature: | 32°F to 104°F(0 to 40 degrees C)  
29 | Humidity(Non condensation): | 20% to 80% (Non condensation)

### 7. **32” Full HD LED Display Monitor.**

<table>
<thead>
<tr>
<th>Sr.NO</th>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Display:</td>
<td></td>
</tr>
</tbody>
</table>
| 2 | Screen Size: | 32” (Diagonal)  
| 3 | Panel: | DIRECT LED  
| 4 | Resolution (HxV): | 1920 x 1080 pixels  
| 5 | Brightness: | 350 cd/m²  
| 6 | Viewing Angle: | 178 degrees  
| 7 | CONNECTION TERMINAL: |  

---

Tender No. HITES/IDN/DRUG-LAB/KATHUA/2019-20

Page 302
<table>
<thead>
<tr>
<th>Sr.NO</th>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>VIDEO IN:</td>
<td>BNC x 1</td>
</tr>
<tr>
<td>9</td>
<td>AUDIO IN (L/R):</td>
<td>RCA x 1 set</td>
</tr>
<tr>
<td>10</td>
<td>COMPONENT/RGB IN:</td>
<td>1 set (BNC x3)</td>
</tr>
<tr>
<td>11</td>
<td>HDMI IN:</td>
<td>HDMI x 1</td>
</tr>
<tr>
<td>12</td>
<td>DVI-D IN/Out:</td>
<td>24pin x 1/24pin x 1</td>
</tr>
<tr>
<td>13</td>
<td>PC IN:</td>
<td>MINI D-SUB 15PIN x1 (Female)</td>
</tr>
<tr>
<td>14</td>
<td>AUDIO IN:</td>
<td>M3 jack x 1</td>
</tr>
<tr>
<td>15</td>
<td>Speaker Out:</td>
<td>External Speaker Jack (Side), 20W (10W x 10W)</td>
</tr>
<tr>
<td>16</td>
<td>Line Out:</td>
<td>RCA Pin (L/R) x1 (Side)</td>
</tr>
<tr>
<td>17</td>
<td>CONTROL TERMINAL:</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>LAN:</td>
<td>RJ45 x 1 (Web Browser Control)</td>
</tr>
<tr>
<td>19</td>
<td>SERIAL Port:</td>
<td>D-SUB 9 pin x 1 (SERIAL IN/Out) RS-232C Compatible</td>
</tr>
<tr>
<td>20</td>
<td>IR IN/OUT:</td>
<td>M3 Jack x 1/x 1</td>
</tr>
<tr>
<td>21</td>
<td>ELECTRICAL:</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Power Requirements:</td>
<td>110-127 V AC, 50Hz/60Hz, 120 V AC 50/60HZ</td>
</tr>
<tr>
<td>23</td>
<td></td>
<td>220-240 V AC, 50/60Hz</td>
</tr>
<tr>
<td>24</td>
<td>Power Consumption:</td>
<td>Less than 250 W</td>
</tr>
<tr>
<td>25</td>
<td>MECHANICAL:</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Temperature:</td>
<td>32°F to 104°F (0 to 40 degrees C)</td>
</tr>
<tr>
<td>27</td>
<td>Humidity(Non condensation):</td>
<td>20% to 80% (Non condensation)</td>
</tr>
</tbody>
</table>
Network switches: refer technical specification of LAN Networking chapter.

- **Digital Public Address System:**

  The system shall provide new and unique features for the market. Each component in the system shall be designed to suit the system needs as required.

  The system shall have the following features:

  - Easy configuration, but without losing the ability to solve complex requests. A configuration wizard and an expert program interface shall be provided. Fast and correct installation shall be possible, but it shall also be possible to handle complex application requirements. A free programmable Task Engine shall be available via the expert mode program interface. The configuration wizard shall be able to provide a step-by-step configuration guide that creates a complete IRIS-Net system configuration file.

  - Due to its flexibility, the system shall eliminate the project risk right from the start. The matrix structure shall be evident throughout the system. Dynamic routing and intelligent audio power distribution shall make the system suitable for almost any application. The system shall be designed to ensure a system-wide intelligent power management architecture. The system shall raise the bar and creates a PA/EVAC system that uses the lowest power consumption for the application. It shall save batteries and maintenance costs!

  - The system shall add pro-sound audio quality level to the PA/EVAC system. This high-quality level shall enable combined use of Fire/EVAC with applications that requires high-quality audio, such as presentation rooms, school stages, etc. The excellent sound quality shall ensure excellent intelligibility in all kind of situations.

  - The new call station shall be designed as a modern device. The new call station shall provide a green LED on the Microphone to show that a call is going across from the call station. The system shall be able to handle up to 16 call stations.
• The system shall be capable to address up to 492 zones with a total speaker load upto 50,000 Watt. It shall be able to handle 4 system program sources and 12 local program inputs.

• It shall be possible to have one or more spare amplifiers in the system to take over from a duty amplifier in case one fails.

• **System Controller**

The system controller shall be an EN54-16 compliant and certified device in a 2 U, 19”-cabinet. The TCP/IP capable network device shall contain all controlling and monitoring functions of a voice evacuation system.

The controller shall manage the supervision of its own operation and that of the connected devices. It shall control and activate the connected amplifiers and spare amplifier and shall replace the amplifier routing and channel that has reported a fault.

The controller shall support single line switching or redundant group A/B switching.

Network connectivity status and fault conditions shall be displayed via LEDs on the front panel.

At least 8000 fault, warning and event conditions shall be logged internally and it shall be reported with the possibility to look real-time into the logging and save the log with logging tools. Four 100V audio inputs shall be routed to 12 speaker line outputs. Each cluster of 6 loudspeaker zones shall allow separate two-channel operation to ensure continuous business music or it shall allow to be configured to double the amount of power in a 6 zone 1 channel cluster.

It also shall have an option to have multiple calls in parallel in a 2 channel operation mode.

It shall be possible to share the amplifier power with multiple routers.
The controller shall provide an internal 14x 4 Audio matrix with full DSP functionally on each of the 8 inputs and 4 outputs. The controller shall operate as a four channel output matrix.

A single system controller shall be able to manage up to 20 routers, 16 call stations and up to 492 loudspeaker circuits. It shall allow up to 4 controllable program inputs.

A built in message manager shall be able to store up to 100 emergency- or business-calls, with a total storage time up to 85 minutes.

It shall be possible to send two different messages simultaneously to individual destinations.

In combination, license free spoken word evac sound files shall be provided in 7 languages.

A separate included tool shall provide on the fly replacing non-evac messages at any time without system interruption or system restart - so called hot swappable messages.

Loudspeaker supervision shall be fully controlled by the controller and executed from the router. The user shall be able to choose between no supervision, impedance measurement, simple EOL boards with pilot tone supervision (requires return wires) or via advanced addressable EOL supervision boards, which requires a ground connection but no additional return wires.

Zones outputs shall be able to handle a load from 2-500 Watt.

Max. 1000 Watt per 6 zones shall be provided.

The controller shall be able to handle up to 2000 Watt load.

It shall be possible to connect to a FPA5000 via Ethernet.
### Technical Data

<table>
<thead>
<tr>
<th>PVA-4CR12Controller</th>
<th>PAVIRO controller including signal processing, routing, system control, and supervision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audio</td>
<td>8 audio inputs, 4 audio outputs</td>
</tr>
<tr>
<td>Safety/redundancy</td>
<td>Internal supervision, system monitoring, watchdog, fault output</td>
</tr>
</tbody>
</table>
| PC configuration and control software | Configuration Wizard: Easy system configuration.  
IRIS-Net: Integration of controller, amplifiers, call stations, routers, and peripheral control; configuration, control, and supervision for complete audio systems; programmable |
| Frequency response (ref. 1kHz) | 20Hz to 20kHz (-0.5dB) |
| Signal-to-noise ratio (A-weighted) | Line in to line out: 106dB typical |
| THD+N               | <0.05%                                                                              |
| Crosstalk (line level) | Line in to line out (0dB gain): <100dB at 1kHz                                      |
| Sample rate         | 48kHz                                                                               |
| DSP processing resolution | 24-bit linear A/D and D/A conversion, 48-bit processing                           |
| Audio inputs (microphone/line level) | MIC/LINE: 2 × 3-pin port, electronically symmetric  
AUX: 2 × Stereo RCA |
| Input level (nominal) | MIC/LINE: 15dBu  
AUX: 9dBu |
| Input level (max. before clip) | MIC/LINE: 18dBu  
AUX: 12dBu |
<p>| Input impedances     | MIC/LINE: 2.2kΩ, AUX: 8kΩ                                                       |
| Commonmode rejection | MIC/LINE: &gt;50dB                                                                   |
| Phantom power, switchable | MIC/LINE: 48VDC                                                                  |</p>
<table>
<thead>
<tr>
<th>A/D conversion</th>
<th>24Bit, Sigma-Delta, 128 times oversampling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audio inputs (100V)</td>
<td>AMPIN: 2 × 6-pinport</td>
</tr>
<tr>
<td>Max. voltage</td>
<td>120V</td>
</tr>
</tbody>
</table>

- Max. current: 7.2A
- Max. power: 500W

Audio outputs (line level)

- Output level (nominal): 6dBu
- Output level (max. before clip): 9dBu
- Min. load impedance: <50Ω
- D/A conversion: 24Bit, Sigma-Delta, 128 times oversampling

Audio Outputs (100V)

- Max. voltage: 120 V<sub>eff</sub>
- Max. current: 7.2A
- Max. power: 500W
- Crosstalk (100V): AMPIN to SPEAKEROUT: <100dB at 1kHz with 1kΩ load

Call station bus (CST)

- Power: +24V DC, electronic fuse
- CAN: 10,20 or 62.5 kbit/s
- Audio: electronically symmetric
- Max. length: 1000m

ANALOG CONTROL IN

- Control inputs: 8 (analog 0-10V/logic control; low: U ≤ 5V DC; high: U ≥ 10V DC; U<sub>max</sub> = 32V DC)

- Reference outputs: +10V, 100mA

- Timesync input: 1 (DCF-77 receiver)

CONTROL OUT HP

- Control outputs: 6 High Power outputs (open collector, U<sub>max</sub> = 32V, I<sub>max</sub> = 1A)

- Reference output V: +24V, I<sub>max</sub> = 200mA
<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Ready/fault output</td>
<td>1(NO/NC relay contact 1A)</td>
</tr>
<tr>
<td>- Slave clock output</td>
<td>1(24VDC, max. 1A)</td>
</tr>
<tr>
<td>CONTROLIN</td>
<td>2 × 10-pin port</td>
</tr>
<tr>
<td>- Control inputs</td>
<td>5 supervised inputs (0–24V, $U_{\text{max}} = 32$ V)</td>
</tr>
<tr>
<td>-</td>
<td>5 isolated inputs (low: $U \leq 5$ VDC; high: $U \geq 10$ VDC; $U_{\text{max}} = 32$ V)</td>
</tr>
<tr>
<td>CONTROLOUT</td>
<td>2 × 10-pin port</td>
</tr>
<tr>
<td>- Control outputs</td>
<td>12 Low Power outputs (open collector, $U_{\text{max}} = 32$ V, $I_{\text{max}} = 40$ mA)</td>
</tr>
<tr>
<td>- Control relay</td>
<td>1(NO/NC relay contacts, $U_{\text{max}} = 32$ V, $I_{\text{max}} = 1$ A)</td>
</tr>
<tr>
<td>Interfaces</td>
<td>1 × RJ-45, 10/100 MB (for PC connection)</td>
</tr>
<tr>
<td>- Ethernet</td>
<td>2 × RJ-45, 10 to 500 kbit/s (for amplifier, router connection)</td>
</tr>
<tr>
<td>DC power input</td>
<td>21–32 VDC</td>
</tr>
<tr>
<td>Power consumption</td>
<td>10 to 250 W</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-5°C to +45°C</td>
</tr>
<tr>
<td>Electromagnetic environment</td>
<td>E1, E2, E3</td>
</tr>
</tbody>
</table>

**Standards**

The device meets the following standards (as of February 2015):

- IEC60065
- EN61000-6-3
- EN50130-4
- EN60945
- EN 50581
• **System Router**

The system router shall be an EN54-16 certified device in a 2 RU, 19"cabinet. The device shall extend the number of zones in a system and shall contain all the necessary controlling and monitoring functions.

The internal supervision system shall monitor the functions and operation of both itself and the connected devices. It shall be capable of re-routing a spare amplifier channel and shall replace an amplifier channel that has reported a fault.

Fault conditions shall also be reported to the connected system controller for operational control and logging purposes. The router shall support single line assignment or redundant group A/B switching.

Connectivity status and fault conditions shall be displayed via LEDs on the front panel, including a zone status LED.

It shall be possible to route at least 4 channels into eight 100V audio inputs to 24 loudspeaker line outputs. The router loudspeaker outputs shall be divided in clusters of 6 loudspeaker line outputs. Each cluster of 6 zones shall allow the same or a different two-channel operation mode to ensure continuous and/or different business music into different zones.

It shall be possible for each router cluster to operate as a 2-in-6 matrix (4 channel input matrix to 2-in 6 cluster).

Zone outputs shall be able to handle a load from 2-500 Watt.

Max. 1000 Watt per 6 zones shall be provided.

The Router shall be able to handle up to a 4000 Watt load.

Integrated loudspeaker supervision shall eliminate the need of amplifier power for supervision, which shall result in very low power consumption.

• **Technical Data**

<table>
<thead>
<tr>
<th>PVA-4R2424ZoneRouter</th>
<th>PAVIR0Routerincludingroutin gandsupervision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audioinputs (100V)</td>
<td>AMPIN:4×6-pinport</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Max. voltage</td>
<td>120V_{eff}</td>
</tr>
<tr>
<td>Max. current</td>
<td>7.2A</td>
</tr>
<tr>
<td>Max. power</td>
<td>500W</td>
</tr>
<tr>
<td>Audio outputs (100V)</td>
<td>SPEAKER OUT: 4 × 12-pinport</td>
</tr>
<tr>
<td>Max. voltage</td>
<td>120V_{eff}</td>
</tr>
<tr>
<td>Max. current</td>
<td>7.2A</td>
</tr>
<tr>
<td>Max. power</td>
<td>500W</td>
</tr>
<tr>
<td>CONTROL IN</td>
<td>4 × 10-pinport</td>
</tr>
<tr>
<td>Control inputs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 supervised inputs (0–24V, U_{max} =32V)</td>
</tr>
<tr>
<td></td>
<td>10 isolated inputs (Low: U \leq 5VDC; High: U \geq 10VDC, U_{max} =32V)</td>
</tr>
<tr>
<td>CONTROL OUT</td>
<td>4 × 10-pinport</td>
</tr>
<tr>
<td>Control outputs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24 LowPower outputs (opencollector, U_{max} =)</td>
</tr>
<tr>
<td>Control relay</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 (NO/NC relay contacts, U_{max} =32V, I_{max} =)</td>
</tr>
<tr>
<td>Interfaces</td>
<td></td>
</tr>
<tr>
<td>CANBUS port</td>
<td>2 × RJ-45, 10 to 500 kbit/s (for controller, router, amplifier connection)</td>
</tr>
<tr>
<td>DC power input</td>
<td>21–32VDC</td>
</tr>
<tr>
<td>Power consumption</td>
<td>5–60W</td>
</tr>
<tr>
<td>Maximum supply current</td>
<td>Standby &lt;250mA</td>
</tr>
<tr>
<td></td>
<td>Idle/Announcement/Alert &lt;200mA</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-5°C to 45°C</td>
</tr>
<tr>
<td>Electromagnetic environment</td>
<td>E1, E2, E3</td>
</tr>
</tbody>
</table>

**Standards:**

The device meets the following standards (as of February 2015):

- IEC 60065
- EN 61000-6-3
- EN 50130-4
- EN 60945
- EN 50581
- **Digital Amplifier**

The 2x 500W Class D, high efficiency amplifier shall be an EN54-16 compliant and certified system device in a 2 RU, 19”cabinet. It shall provide 70/100V loudspeaker output voltages that are galvanically separated. The amplifier shall be permanently monitored by the system controller.

A special standby mode shall be provided for saving energy during the time the amplifier is not in use with respect to all economical and supervision aspects.

System control and audio interconnections shall be done via RJ45 connectors.

The amplifier shall be used as a system amplifier, but it shall also be possible to use the amplifier standalone.

As a system amplifier, four automatic selectable audio inputs via RJ45 shall be available. It shall also be possible to use a local input without losing system and line supervision.

It shall be a requirement that local input is used in case of standalone mode.

The local input shall be configurable in a way that it can be used as source input for in an installed system, for example for an external PA or local source input. The amplifier shall have the following specifications:

- Max amplifier load: 2x 500 Watt
- Class D amplifier
- 4 channel input on RJ45 connector, amp link in and out (4 channel dynamic input channel switching for each amplifier)
- Local input on amplifier: Enabled via software configuration or automatically selected when amplifier address is set to address "0"; System channel 4 will be used as supervision channel in case local inputs are used.
- Loop through on RJ45 connector (4 channels)
- Build in Limiter
- AC Power switch on rear side
- 24V DC Input
- Front to rear air ventilation
### Rated load impedance (output power)

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Impedance/Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>100V</td>
<td>20Ω (500W)</td>
</tr>
<tr>
<td>70V</td>
<td>10Ω (500W)</td>
</tr>
</tbody>
</table>

Rated output power, 1kHz, THD ≤ 1%

$$2 \times 500W$$

Rated input voltage

+6dBu

Max. RMS voltage swing, 1kHz, THD ≤ 1%, without load

- 100V: 110V
- 70V: 78V

Voltage gain, ref. 1kHz, fixed

- 70V: 33.2dB
- 100V: 36.2dB

Maximum load capacitance

2μF

Input level, max.

+18dBu (9.75Vrms)

Frequency response, ref. 1kHz, rated load, gain

50Hz to 25kHz

Input impedance, active balanced

20kΩ

Signal-to-noise ratio (A-weighted)

> 104dB

Output noise (A-weighted)

< -62dBu

Crosstalk, ref. 1kHz

< -85dB

Output stage topology

Class-D, transformer, floating

Power requirements

- AC: 115–240V (-10/+10%)²
- DC: 21–32V

Power consumption, AC and DC

See section “Power consumption” in operation manual

Inrush current

2A

Inrush current, after five-second power cycle

1.3A

Mains fuse

T6.3A (internally)

DC fuse

30A (internally)

Ground fault

R < 50kΩ

CANBUS port

2 × RJ-45, 10 to 500 kbit/s
<table>
<thead>
<tr>
<th>Protection</th>
<th>Audioinput level limiter, RMS output power limiter, high temperature, DC, short circuit,</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling</td>
<td>Front-to-rear, temperature-controlled fans</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-5°C to +45°C</td>
</tr>
<tr>
<td>Safety class</td>
<td>Class I</td>
</tr>
<tr>
<td>Electromagnetic environment</td>
<td>E1, E2, E3</td>
</tr>
</tbody>
</table>

- In DC mode and in continuous alarm signal operation, output signal limited by 3 dB max.

- Reduced output power at mains voltages below 115V

**Standards**

- EN50130-4
- EN50581
- EN55103-1/2
- **EN 61000-3-2/3**
- EN61000-6-3
- IEC60065
- EN60945

**Digital Call Station**

The call station shall be an EN54-16 compliant and certified user interface.

It shall be designed in a modern and robust chassis with a graphical display.

As standard, the call station shall have a gooseneck microphone with pop shield and permanent monitoring, an illuminated LC-display and an integrated loudspeaker to be used for system sounds.

The operation status shall be permanently supervised by the system controller.

It shall be possible to modify the call station to suit the user’s requirements by connecting up to five remote call station keypads, each with 20 free customizable functions and selection buttons.

It shall be possible to extend the call station at the right and at the left side. It shall be possible to mount a maximum of 3 additional emergency buttons on the call.
station. Optionally it shall be possible to mount a key switch to lock or enable call station functions with a key switch or to give access to a second access level.

The call station shall have a built-in numerical keypad; it shall be possible to enable or disable the keypad during configuration.

The call station shall have the following specifications:

- Five menu/function keys (pre-programmed) – four buttons shall provide each 1 LED (2 LEDs shall be green and 2 LEDs shall be yellow).

- Green led on the microphone which is active during a call.

- 15 function and speed dial buttons (customizable), two LEDs (green/red) per button.

- Button functions shall be programmable such as:
  - Zone select, source select, level control, emergency on/off, message on/off, failure acknowledge/reset.
  - Switching output trigger on/off or 0 to 10V, select scheduled events, scheduled event on/off.

- Fascia cover with transparent areas for customizable labels.

- Multilanguage LCD display informs about system status, system faults, selected zones, source select, clock, different kind of additional (failure) messages shall be free configurable.

- Supervised electret microphone, with limiter and a speech filter for excellent speech intelligibility.

- CAT5 cable for data and audio connection to controller (CAN bus, up to 1000 meter).

- It shall be possible to daisy chain 4 call stations.

- It shall receive audio and operational control signals from the controller and report its status to the system controller.

- Internal monitoring with error logging – complying with all relevant national and international standards.

**Technical data**

<table>
<thead>
<tr>
<th>CANBUS port</th>
<th>10,20,or62.5kbit/s,1×RJ-45,max.length 1000m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum micinput level</td>
<td>-21dBu</td>
</tr>
<tr>
<td>Specification</td>
<td>Details</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>----------------------------------------------</td>
</tr>
<tr>
<td>Maximum line input level</td>
<td>+4 dBu</td>
</tr>
<tr>
<td>Maximum NF output level</td>
<td>+12 dBu</td>
</tr>
<tr>
<td>Buttons</td>
<td>5 pre-programmed, 15 programmable zone/function keys</td>
</tr>
<tr>
<td>Color</td>
<td>RAL9017 (traffic black)</td>
</tr>
<tr>
<td>Indicator lights</td>
<td>Power (green), Fault (yellow), Alarm (red)</td>
</tr>
<tr>
<td>LC display</td>
<td>Back-lit LC display (122 × 32 pixel)</td>
</tr>
<tr>
<td>Ports</td>
<td>1 CST BUS port (Control data + Audio + Power supply, RJ-45)</td>
</tr>
<tr>
<td></td>
<td>1 microphone port (phone jack)</td>
</tr>
<tr>
<td></td>
<td>1 EXT OUT port (call station extension, RJ-12)</td>
</tr>
<tr>
<td>DC power input</td>
<td>15–58 V</td>
</tr>
</tbody>
</table>

**Standards:**

- IEC 60065
- EN 61000-6-3
- EN 50130-4

**ROUND METAL CEILING LOUDSPEAKER**

**Technical Specifications**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated power, Watts</td>
<td>6</td>
</tr>
<tr>
<td>Transformer tapping’s 100 volt line, Watts</td>
<td>6/3/1.5/0.75/0.25</td>
</tr>
<tr>
<td>Transformer Impedance, Ohms</td>
<td>1.67k/3.34k/6.67k/13.3k/40k</td>
</tr>
<tr>
<td>70.7 volt line, Watts</td>
<td>3/1.5/0.75/0.375/0.125</td>
</tr>
<tr>
<td>Driver impedance, Ohms</td>
<td>8</td>
</tr>
</tbody>
</table>
Effective frequency range, Hz (BS6840)  
120-17,500

S.P.L. @ 1m, 1watt, dB  
90

S.P.L. @ Full power/1m, dB  
97

Dispersion at 1,000 Hz, Degrees  
180

Directivity Q factor, 1k Hz  
2.3

Dimensions front and depth, mm  
181 x 70

Net weight, Kgs  
0.77

Colour / Finish  
White, RAL9016

Material  
Steel

Mounting  
Snap-on, Metal clip x 2

- **Access Control System:**

The under-mentioned mandatory requirements are to be fulfilled by the security system integration company employed by the principal contractor and shall be included with their technical and commercial offers for the acceptance. Further, the system integration company must make available the following documents from the manufactures of the key equipments listed here under:-

- Technical compliance to the tender specifications from the equipments manufacturer

- Letter from the equipment manufacturer that the system integration company is an authorized Distributor / dealer of the manufacturer and is authorized for execution of these works.

- Letter from the equipment manufacturer that they shall provide all required help & guidance to the specified system integration company for successful execution of the system supplied by them.

- List of the key equipments for which the above documents/conformance from the manufactures are required:

  A) Biometric & Proximity Reader
B) Controller & Access control software.

Specifications for Finger-print (FP) Biometric Reader & Operations

- The Finger-print (FP) biometric reader provided 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.

- The FP biometric reader shall provide two-factor authentication with the combination of a proximity [/contactless smart] card and a fingerprint biometrics.

- The FP biometric reader together with the proximity [/contactless smart] card shall support operation with 1:1 verification mode or 1:N, identification mode.

- The FP biometric 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.

- The FP biometric reader shall include a FP scanner that uses capacitive verification techniques for the live finger recognition and resistance of the human skin.

- The FP biometric reader provided shall have a read tolerance of at Operating Temperature: \(-15^\circ C \) to \(+50^\circ C\)

- The same FP biometric reader provided shall be able to be used for both access control and as an enrollment station.

- The specifier shall supply and install the necessary software to manage the FP enrollment for all users and configuration of the FP access control operations.

- The software provided shall be integrated to the Access Control System for access control and monitoring.

- During enrollment process, the FP biometric reader and software used for capturing the fingerprint shall provide, but not limited to the following:
  
  - Provide full visibility of the ridge details including texture, continuity, edges and pores.
  
  - Allow for real-time on-screen preview of the FP image while performing the FP capture.
  
  - Surface Mount fingerprint reader with integrated proximity (EM and HID 125kHz compatible)
The FP enrolment process shall support a percentage estimation of the image quality such that the operator can accept or reject the enrolled FP.

Storage capacity: 9500 Fingerprints, 1:1000 identification: 970msec

The enrolled FP templates shall be stored in the Access Control System centralized database as well as within the reader's memory storage.

The FP templates stored shall incorporate a date stamp and shall record the number and/or name of the finger taken.

Adjustable Wiegand protocol (1 to 128-bit) is utilized in the biometry reader which makes it compatible with controllers with Wiegand interface

Compatibility with XPR Control Panels: EWS

Separate BioManager Software available free when used with third party controllers

Enrollment can be done from any biometric reader in the network or from Desktop USB Enrollment Unit

The FP images captured shall be stored in an open format such as jpeg or bmp

for the purpose to export for further use by another application when required.

Compatible with any Wiegand controller

**Access control Controller :-**

<table>
<thead>
<tr>
<th>Communication</th>
<th>NATIVE TCP/IP + RS485</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max number of controllers per installation</td>
<td>Unlimited</td>
</tr>
<tr>
<td>Max number of doors per system</td>
<td>Unlimited</td>
</tr>
<tr>
<td>Mounting</td>
<td>Surface</td>
</tr>
<tr>
<td>Housing</td>
<td>Dark mat grey metal housing (only with the EWSIH reference)</td>
</tr>
<tr>
<td>Number of Wiegand Readers (26 or 34bits)</td>
<td>2 (1 with APB), Programmable wiegand interface 8bits to 128bits</td>
</tr>
<tr>
<td>Number of Users</td>
<td>15000 Max</td>
</tr>
<tr>
<td>Number of Events</td>
<td>30000 Max</td>
</tr>
<tr>
<td>Specification</td>
<td>Details</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Number of Time Zones</td>
<td>24</td>
</tr>
<tr>
<td>Number of Users Groups</td>
<td>Unlimited</td>
</tr>
<tr>
<td>Number of Bank Holidays</td>
<td>32</td>
</tr>
<tr>
<td>Internal Memory</td>
<td>Yes, with time and date back-up by Lithium CR2032 battery</td>
</tr>
<tr>
<td>Door relays</td>
<td>2+2 (2 x 10A)</td>
</tr>
<tr>
<td>Programmable Relays</td>
<td>2+2 (2 x 10A)</td>
</tr>
<tr>
<td>Programmable Inputs</td>
<td>2 (Opto paired)</td>
</tr>
<tr>
<td>Exit Button Output</td>
<td>2+2 (1 per door)</td>
</tr>
<tr>
<td>Door Contacts</td>
<td>2+2 (1 per door)</td>
</tr>
<tr>
<td>Tamper-proof protection</td>
<td>Opening and Wrenching (only for EWSIH reference)</td>
</tr>
<tr>
<td>Controller Updates (Local or remotely via)</td>
<td>RS485 bus or TCP/IP network</td>
</tr>
<tr>
<td>Biometric Readers</td>
<td>XPR Biometric readers use the controllers communication buses (RS485 or IP)</td>
</tr>
<tr>
<td>Adressing</td>
<td>Every single controller has a unique address</td>
</tr>
<tr>
<td>Status LEDs</td>
<td>16</td>
</tr>
<tr>
<td>Power Supply</td>
<td>12VDC</td>
</tr>
<tr>
<td>Programming and System Management</td>
<td>Windows Software PROS</td>
</tr>
<tr>
<td>Dimensions (mm)</td>
<td>152X85X27 (EWSI) 200X144X43 (EWSIH)</td>
</tr>
</tbody>
</table>
CHAPTER-13
TECHNICAL SPECIFICATIONS- HVAC WORKS

1.1. SYSTEM DESIGN DATA

A) DESIGN PHILOSOPHY

HVAC system in the Hospitals, Labs & healthcare stands out for its complexities and stringent demands on indoor air quality, airflow patterns, cross contamination control, odor control and noise control etc. The hospital air conditioning system further demands more care in energy aspects due to its longer hours of operations.

The following factors have been considered for the design of HVAC services:

- Individual and quickly responding temperature control for each area.
- Draft-free air distribution.
- Fresh air or makeup air supply to maintain adequate Indoor Air Quality.
- Humidity control
- Acceptable noise level.
- Separate AHU’s for different floors / zones to avoid mixing of air and Operational.
- AHU with Heat Recovery units in OTs.

To effectively design an HVAC system for this hospital building, the design is made as per the building layout and the departmental areas or zones. These zones are broadly classified as follows.

- Inpatient Wards/ ICUs : For residential patient.
- Radiology Areas : Diagnostics-ray, MRI, CT Scan, Laboratories.
- Operation Theatres : OTs and its allied areas
- Radiation Oncology : LINAC machines and allied rooms, treatment bays, physicians, nuclear medicines
- OPD and Emergency : OPD areas and emergency areas

The individual requirements of the above zones and areas have been considered for designing the HVAC system as per requirements.

1.2. GENERAL

The system design, basis of design, requirements and other relevant data are outlined in this section.

A) TENDER DRAWINGS

For guidance of the bidder, drawings (Schematic HVAC Layout/External Burried Pipe layout, Plant Room Layout etc.) are enclosed with these tender documents. These drawings are broadly indicative of the work to be carried out. The contractor on award of work will furnish detailed stage-wise working drawings as required in advance for approval of Engineer.

B) SHOP DRAWINGS/TECHNICAL DATA SHEETS

The contractor shall prepare and furnish all shop drawings including floor plans & Terrace, Schematic HVAC Layout/External HVAC pipe routing etc.
The manufacturing of equipment shall be commenced only after the shop drawings/GA Drawings/ technical data sheet along with pump curves are approved in writing by the Engineer. Such drawings shall be co-ordinated with other services work. These shop drawings will be approved by HITES which will be considered as base for execution of HVAC work.

C) COMPLETION / AS BUILT DRAWINGS
On completion of the work and before issuance of certificate of virtual completion, the contractor shall submit to the Engineer –in-Charge, General layout drawings, drawn at approved scale indicating layout of pump house piping and its accessories “As installed”. AS built drawings shall be prepared taking approved shop drawings as base & incorporating all changes/ modifications as per site conditions. These drawings shall include the following:-
- General Layout of Plant Room including all details mentioned in clause 1.2.
- Panels and other equipment/accessories location and their dimensions etc.
- HVAC floor layout including Terrace Plan etc.
- Complete schematic as installed.
- Route of all cables and pipes run along with detail sizes and mode of Installation.

D) DRAWINGS & DOCUMENTS
The contractor shall submit to the Engineer, the following documents on completion of the work and before issuance of virtual completion.
- Warranty for required equipment installed like Pumps, Panels, Chillers, HWG, AHU, FCU etc.
- As Built Drawings
- Material Test Certificates
- Catalogues/Brochures
- Operation and Maintenance Manuals
- List of recommended spares and consumables
- All approvals including technical approvals and sanctions
- NoC from Fire authority before commencement of execution & after completion of entire work etc.

1.3. MANUFACTURING
The responsibility for ensuring the manufacture of the equipment as per the specifications shall be solely that of the contractor. The contractor shall be responsible for selection of materials as per agreed specifications.

1.4. MAKE OF MATERIALS/ MANUFACTURER’S INSTRUCTION
Only approved makes as mentioned in our approved make list of tender documents of material shall be used. The Contractor shall furnish Technical data sheets / GA drawings of all items before placing P.O. The contractor shall get the samples of required items approved from the HITES as conveyed by E-I-C before commencing the supply. In case of any discrepancy/anomalies wrt specifications, prior intimation from
Contractor to E-I-C to be given. Final decision lies with HITES for according approvals.

Any specific instruction furnished by manufacturer covering the points not mentioned in technical specifications of the tender shall be brought to the notice of E-I-C in writing for further instructions in this regard at appropriate time.

1.5. MATERIAL TESTING
The E-I-C shall have full power to get any material of work to be tested by an independent agency at contractor’s expense in order to prove the soundness and adequacy.

A) INSPECTION AND TESTING
- All equipment shall be inspected and tested as per an agreed Quality Assurance Plan before the same is packed and dispatched from the contractor’s works. The contractor shall carry out tests as specified/directed by engineer.
- The E-I-C may, at his sole discretion, carry out inspection at different stages during manufacturing and final testing after manufacturing.
- Approvals or passing of any inspection by the engineer or his authorized representative shall not, however, prejudice the right of the engineer to reject the plan if it does not comply with the specification when erected or give complete satisfaction in service.

B) TRAINING OF DEPARTMENT PERSONNEL
- The contractor shall train the CLIENT/ HITES’s personnel to become proficient in operating the equipment installed. Training shall be done before the expiry of the defects liability period (one year after completion & handing over).
- The period of training shall be adequate and mutually agreed upon by the Engineer and contractor.
- The CLIENT/ HITES’s personnel shall also be trained for routine maintenance work and lubrication, overhauling, adjustments, testing, minor repairs and replacement.
- Nothing extra shall be paid to the contractor for training CLIENT/ HITES’s personnel.

1.6. PERFORMANCE GUARANTEE
At the close of the work and before issue of final certificate of virtual completion by the engineer, the contractor shall furnish written guarantee indemnifying the CLIENT/ HITES against defective materials and workmanship for a period of one year after completion and handing over. The contractor shall hold himself fully responsible for reinstallation or replace free of cost to the CLIENT/ HITES.
- Any defective material or equipment supplied by the contractor.
- Any material or equipment supplied by the CLIENT/ HITES which is proved to be damaged or destroyed as a result of defective workmanship by the contractor.
The detailed specifications and specific requirements are outlined in the subsequent sections.

A. LOCATION
Proposed Construction of 80 Bedded Mother & Child Hospital at Bathinda (Punjab)

B. SCOPE OF WORKS
The work proposed under this tender includes providing and fixing HVAC systems for the above work. Providing and fixing at site all main equipment associated with air-conditioning and ventilation for the above. To execute all incidental work at site including material supply at site associated with the system asked in the specifications. Nature of such works will be sheet metal ductwork, air distribution devices viz. grilles and diffusers, copper refrigerant piping and its insulation, drain piping etc., incidental civil works, incidental electrical works, cable, control panel etc. at site for all manufactured items at works and also items fabricated at site. Routine Testing, pressure testing of fabricated components, commissioning of complete plant at site. Performance testing at site of complete air-conditioning, air-cooling and ventilation system / installations

C. BASIS OF DESIGN
Outside Conditions: As per relevant norms & standards

<table>
<thead>
<tr>
<th>Ventilation</th>
<th>As per ASHRAE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toilets</td>
<td>6/12 Air changes per hour</td>
</tr>
</tbody>
</table>

CLIMATE CONDITIONS:

<table>
<thead>
<tr>
<th>Project Location:</th>
<th>Baddi (Himachal Pradesh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latitude (°N)</td>
<td>To be provided by EPC Contractor</td>
</tr>
<tr>
<td>Longitude</td>
<td>To be provided by EPC Contractor</td>
</tr>
<tr>
<td>Elevation</td>
<td>To be provided by EPC Contractor</td>
</tr>
</tbody>
</table>

OUTDOOR DESIGN CONDITIONS:

<table>
<thead>
<tr>
<th>Project Location:</th>
<th>Baddi (Himachal Pradesh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latitude (°N)</td>
<td>To be provided by EPC Contractor</td>
</tr>
<tr>
<td>Longitude</td>
<td>To be provided by EPC Contractor</td>
</tr>
<tr>
<td>Elevation</td>
<td>To be provided by EPC Contractor</td>
</tr>
</tbody>
</table>

INSSIDE DESIGN CONDITIONS:

NBC-2016- Table 6, Clause 8.1.1 of Part 8 building services. Section 3 Air Conditioning, Heating and Mechanical ventilation

ISHRAE Hand BOOK - Design parameters for areas affecting patient care in hospitals and outpatient facilities (Table 1-t-74)
D. INSIDE DESIGN CONDITIONS

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Space Name / Pressure type</th>
<th>Temperature in °C</th>
<th>RH %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Sample collection Treatment Rooms (±)</td>
<td>23 ± 1.1</td>
<td>50 ± 10 %</td>
</tr>
<tr>
<td>2.</td>
<td>X-ray/MRI/CAT Scan (-)</td>
<td>23 ± 1.1</td>
<td>50 ± 10 %</td>
</tr>
<tr>
<td>3.</td>
<td>Labs (-)</td>
<td>23 ± 1.1</td>
<td>50 ± 10 %</td>
</tr>
<tr>
<td>4.</td>
<td>Pre/Post IPD (+)</td>
<td>23 ± 1.1</td>
<td>50 ± 10 %</td>
</tr>
<tr>
<td>5.</td>
<td>Intensive Care Unit (+)</td>
<td>22 ± 1.1</td>
<td>50 ± 5 %</td>
</tr>
<tr>
<td>6.</td>
<td>Operation Theatres (+)</td>
<td>21 ± 1.0</td>
<td>50 ± 5 %</td>
</tr>
<tr>
<td>7.</td>
<td>Doctors Rest Rooms (±)</td>
<td>23 ± 1.1</td>
<td>50 ± 10 %</td>
</tr>
<tr>
<td>8.</td>
<td>Isolation rooms (-)</td>
<td>23 ± 1.1</td>
<td>50 ± 10 %</td>
</tr>
<tr>
<td>9.</td>
<td>Patient Room (±)</td>
<td>23 ± 1.1</td>
<td>50 ± 10 %</td>
</tr>
</tbody>
</table>

All inside conditions of respective rooms will be correlated as per relevant norms & standards.

Winter - Inside temperature not to fall below 21.0 Deg. C Dry Bulb Temperature.

Outdoor Air (Fresh Air): As per NBC/ISHRAE/ASHRAE standards.

Lighting / Equipment Load/Occupancy: As per NBC/ISHRAE/ASHRAE standards

Based on the area wise detailed heat loads of the above design data and the details the estimated loads are summarized as below for different buildings:
The tables should be considered as a guiding reference. Detailed Heat Load Calculation needs to be submitted by Contractor. Equipment sizes shall be followed as per BOQ provisions.

E. AIR-CONDITIONING SYSTEM DESIGN

To cater total air-conditioning load, it is proposed to install Variable Refrigerant Volume/ Flow (VRV/VRF) system with cooling & heating modes to provide year round thermal environmental control for the above areas.
The Outdoor Units shall be installed at space allocated at terrace of building and copper piping, cabling etc shall be done to various floors as per requirements. The system shall be complete with electrical panel boards, power cabling, control cabling, earthing and controls.

VARIABLE REFRIGERANT VOLUME/ FLOW SYSTEM

1. SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of Variable Refrigerant Volume System. The system selected is a
modular system, with number of indoors connected to centrally located outdoor units. The outdoor units for all the system shall be air cooled type.

2. **TYPE**

Unit shall be air cooled, variable refrigerant volume air conditioner consisting of one outdoor unit and multiple indoor units. Each indoor unit having capability to cool independently for the requirement of the rooms. All indoor units shall be provided with isolation valves so that a particular unit can be isolated and removed for servicing, while system keeps functioning in normal way. All the units shall be suitable for operation with 415 V +/- 10%, 50 Hz +/- 3%, 3 Phase supply for outdoor units; & 220 V +/- 10%, 50 Hz +/- 3%, 1 Phase supply for indoor units.

It shall be possible to connect multiple indoor unit on one refrigerant circuit. The indoor units on any circuit can be of different type and also controlled individually. Following type of indoor units shall be connected to the system:

- Ceiling mounted cassette type.
- Ceiling mounted ductable type.
- Wall mounted Hi-Wall type.
- Floor mounted type.

The outdoor unit shall be pre-charged with first charge of refrigerant. Additional charge shall be added as per refrigerant piping at site.

**OUTDOOR UNIT**

Outdoors units of the VRV system shall be compact air cooled type, factory assembled, weather proof casing constructed from heavy gauge mild steel panels with powder coated finish.

The outdoor unit should comprise of Inverter controlled Twin Rotary Compressor / Scroll Compressor

Each module of outdoor unit must have at least 100% of Variable compressor which can work on Part load Suitable to operate at heat load proportional to indoor requirement.

The ODU must deliver COP of minimum 5.8 at 50 % load. The outdoor units must be suitable for up to 225 m refrigerant piping between outdoor unit & the farthest indoor units. Allowable level difference between outdoor unit & indoor units shall be 50 m in case of outdoor unit on top & 40 m in case of outdoor unit at bottom.

Allowable level difference between various indoor units connected to one outdoor unit shall be up to 15 m. The outdoor units shall be suitable to operate within an ambient temperature range of 2 Deg C to 52 Deg C or as per OEM standard in cooling mode and heating mode.

The entire operation of outdoor units shall be through independent remotes of indoor units. No separate Start/Stop function shall be required.

Complete refrigerant circuit, oil balancing/ equalizing circuit shall be factory assembled & tested.

In case of outdoor units with multiple compressors, the operation shall not be disrupted with failure of any compressor.

The noise level shall not be more than 70 dB (A) at normal operation measured horizontally 1m away and 1.5 m above ground level.
I. COMPRESSOR
The compressor shall be high efficiency scroll / rotary type and capable for capacity controlling. It shall change the speed / refrigerant mass flow rate in accordance to the variation in cooling load requirement. Refrigerant mass flow rate can be changed by speed modulation of compressor. System shall incorporate liquid subcooling mechanism with liquid injection at intermediate pressure. All inverter shall be IGBT (insulated gate bipolar transistor) type for efficient and quiet operation. All outdoor units shall have multiple steps of capacity control to meet load fluctuation and indoor unit individual control. All parts of compressor shall be sufficiently lubricated. Forced lubrication may also be employed. Oil heater shall be provided in the compressor casing.

ii. HEAT EXCHANGER
The Heat Exchanger shall be constructed with copper tubes mechanically bonded to aluminum fins to form a cross fan coil and larger surface area. The fins shall have anticorrosion treatment for Heat Exchanger Coil. The treatment shall be suitable for areas of high pollution, moisture and salt laden air. The casings, fans, motors etc. shall also be with anticorrosion treatment as a standard features. The unit shall be provided with necessary number of direct driven low noise level propeller type fans arranged for vertical / horizontal discharge. Each fan shall have a safety guard.

iii. REFRIGERANT CIRCUIT
The Refrigerant Circuit shall include a liquid receiver / accumulator, liquid & gas shut off valves and a solenoid valve. All necessary safety devices shall be provided to ensure the safety operation of the system.

iv. SAFETY DEVICES
All necessary safety devices shall be provided to ensure safe operation of the system. Following safety devices shall be part of the outdoor unit:
- High pressure switch,
- low pressure switch,
- fuse,
- crankcase heater,
- fusible plug,
- over current protection for inverter, and
- Short recycling guard timer

v. REFRIGERANT PIPING
a. All connections of Refrigerant piping shall be in high grade Copper of Refrigeration quality with Eddy Current Testing and material test Certificates.
b. All connections, tees, reducers etc. shall be standard make fittings.
c. All refrigerant pipes and fittings shall be type ‘L’ hard drawn copper tubes and wrought copper fitting suitable for connection with silver solder. The copper thickness of wall shall be 20G/ 22G(0.7 to 1 mm)
d. All joints in copper piping shall be swaged joints using low temperature brazing and/or silver solder. Before jointing any copper pipe or fittings, its interior 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 construction of the joints. Subsequently, it shall be thoroughly blown out using nitrogen.

e. Refrigerant lines shall be sized to limit pressure drop between evaporator and condensing unit to less than 0.2 kg per Sq.cm.

f. After the refrigerant piping installation has been completed the refrigerant piping system shall be pressure tested using nitrogen. Pressure shall be maintained on the system for 24 hours.

g. The system shall then be evacuated and held for 24 hours.

h. All refrigerant piping shall be installed strictly as per the instructions and recommendations of air conditioning equipment manufacturers.

i. For outdoor piping, the finish shall be woven GRP Mat finished with coloured Epoxy paints to withstand outside ambient conditions and UV Radiation.

j. Insulation of pipes shall be carried out with insulation tubes of appropriate thickness so that condensation does not occur.

vi. OIL RECOVERY SYSTEM

Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigerant piping. System shall be designed for proper oil return to compressor along with the distribution of oil to individual compressor. The refrigerant piping shall be extended upped 100 M with 50-M level difference without oil traps.

3. SPECIFICATIONS OF INDOOR UNITS:

The units include pre-filter, fan section and DX coil section. The housing of units shall be light weight powder coated galvanized steel. Units shall have external casing of ABS Plastic for supply and return air.

4. INDOOR UNITS

Units shall be factory assembled, wired, piped and tested. Units shall have DX coils with copper tubes and bonded aluminium fins for highly efficient heat transfer. Units shall have Centrifugal fans for adequate amount of Air circulation and low Noise. Units shall have inlet filters, which are easily cleanable and replaceable. All components of Units are easily accessible for connection, repairs and maintenance. Units shall have very low noise. All units with Factory manufactured Units, Grills shall have auto swing feature for proper Air distribution. All units shall be controlled by electronic Expansion Valves operated by microprocessor thermostat based temperature control to deliver cooling/ heating as per the heat load of the room.
All units mounted inside the ceiling shall have fans capable of sustaining duct connections, and special filters if necessary.

Visible indoor units shall have wireless remotes. Price of the same shall be included in cost of unit by default.

Concealed indoor units shall have sensor mounted on supply air grilles / diffusers which can be controlled with wireless remotes.

Anticorrosion treatment for avoiding corrosion of coils.

All units shall have adequate insulation or Lining to avoid condensation.

Cooling coil and refrigeration parameters shall be designed in such a way that supply air temperature shall not be less than 140°C or 10°C above room dew point temp, whichever is more. Contractor shall guarantee inside conditions with selected supply air temperature.

5. **CEILING MOUNTED CASSETTE TYPE UNIT (MULTI-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 galvanised steel. The body shall be light in weight and shall be possible to suspend from four corners.

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 centre.

Each unit shall have high lift drain pump, fresh air intake provision, low gas level detection system and very low operating sound.

Unit must be insulated with sound absorbing thermal insulation material, Polyurethane foam. The sound pressure level of unit at the highest operating level shall not exceed 46 dB(A).

6. **CEILING MOUNTED DUCTABLE TYPE UNIT**

Unit shall be suitable for ceiling mounted type. The unit shall include pre filter, fan section & DX-coil section. The housing of unit shall be light weight powder coated galvanized steel. The unit shall have high static fan for ductable arrangement. Each unit shall have high lift drain pump.

The Sound Pressure level of unit at the highest operating level shall not exceed 38 dB (A), at a vertical distance of 1.5 m below the units with duct connected to the unit.

7. **HIGH WALL MOUNTED UNITS**

The units shall be high wall mounted type. The unit shall include 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.

The sound pressure level of unit at the highest operating level shall not exceed 46dB(A).

8. **FLOOR MOUNTED UNITS**

The unit shall be suitable for floor mounting. The unit shall include, pre-filter fan section, DX. Coil section. The housing of unit shall be light weight powder coated galvanized / anodized aluminum panels. Unit shall have an attractive external casing with supply & return air grilles.

9. **CENTRAL REMOTE CONTROLLER**

A multi-functional microprocessor based centralized controller (central remote controller) shall be supplied as an optional accessory.

The controller shall be able to control upto min. 64 zones of 64 groups (each group consisting of max.16 units) or 128 nos. of indoor units with the following functions.
- Temperature setting for each zone, or group, or indoor unit.
- On/Off as a zone or individual unit.
- Indication of operating condition.
- Select ON of all operation modes for each zone.

The controller shall have wide screen liquid crystal display and shall be wired by a non-polar 2 wire transmission cable to a distance of 1000m away from the indoor unit.

The controller shall be integrated to BAS system thru software for monitoring & controlling of all above parameters including start/stop of each indoor/outdoor unit. All necessary interface cards/units should be supplied as a part of the system to integrate to the BAS Software.

10. **CONDENSATE DRAIN PIPING:**

All pipes to be used for condensate drain shall be PVC pipe conforming to IS: 4985 Class I & all joints should be Gluing or solvent cementing as per manufacturer recommendation. U-trap shall be provided at the end. Pipe insulation on drain pipe shall be preferably nitrile rubber of suitable thickness or as per OEM standard.

**Mounting**

All indoor units shall be mounted with Brackets; Hangers etc. with proper size anchor Fasteners

11. **ELECTRICAL INSTALLATION**

For Variable Refrigerant flow systems, power will be provided near outdoor unit location. HVAC Contractor to provide suitable distribution panel along with 3-phase power to outdoor units and single phase power to all indoor units fed by these outdoor units. Power/control cabling along with supports shall be included.

**vii. INSTALLATION:**

a. The units shall be mounted on ribbed rubber pads for vibration isolation. The contractor shall supply the required charge of refrigerant, lubricant and other consumables, for commissioning and testing of the equipment.

b. All the equipment shall be thoroughly tested and checked for leaks. All safety controls shall be suitably set and a record of all setting shall be furnished to the project supervisor.

c. Providing and fixing M.S. structural support for condensing unit with vibration isolator pad in-between support and structure and vibration isolation suspender and pads for evaporating units shall be in scope of contractor.

**AIR COOLED SPLIT AIR CONDITIONING UNITS**

i. **SCOPE**

The scope of this section comprise the supply, erection, testing and commissioning of Air Cooled Split Units conforming to these specifications and in accordance with the requirements. The BEE-star rating of the units shall be as per requirement.

ii. **TYPE**
The Split Units shall consist of hermetically sealed compressor, motor, air cooled condenser, integral refrigerant piping and wiring, all mounted on a steel frame. Indoor unit to be installed for Split Unit within building, shall be housed in insulated cabinet consisting of cooling coil, blower with motor, filter & insulated drain pan. Split unit must deliver specified capacity after taking into account loses due to piping length & site conditions.

iii. **CAPACITY**
The refrigeration capacity of Packaged Unit and Room Air Conditioners, split unit shall be as shown on Drawings and as per requirements.

iv. **COMPRESSOR AND MOTOR**
Compressor shall be hermetically sealed rotary compressor, swing type, serviceable type and shall have dual pressure stat, and an operating oil charge. The motor shall be suction gas cooled and shall be sealed against dirt and moisture. The motor shall be suitable for 415±10% / volts or 230±6 % volts, 50 Hz, A.C. supply.

v. **REFRIGERANT PIPING AND CONTROLS**
Refrigerant piping and fittings interconnecting compressor condenser shall be all copper and valves shall be brass / gunmetal construction. The refrigerant used shall be ozone friendly HFC or any other CFC free refrigerant.

vi. **CASING**
The indoor & outdoor units shall be sectionalized / cabinet construction. Indoor units shall be consisting of fan section, coil section, filter section, and drain pan. Outdoor unit shall consist of condenser coil, fan & compressor. In case of package units, the compressor shall be mounted within the indoor units and in case of split unit, the compressor shall be mounted with the outdoor units. Each section shall be constructed of thick sheet steel all welded / bolted construction, adequately reinforced with structural members and provided with sufficient access panels for proper lubrication and maintenance. Base panel shall be constructed of fabricated steel structure provided with an under frame suitably braced. Each unit shall include one piece drain pan constructed of 20 gauge galvanized sheet steel plate or stainless steel. Drain pan shall extend under coil and fan sections with drain connections. Removable panels in fan and coil sections shall provide access to all internal parts. Panels shall be internally lined with 2.5 cm thick fibreglass as per section “Insulation” for the thermal insulation and acoustic lining.

vii. **FAN MOTOR AND DRIVE**
Fan motor shall be suitable for 415± 10% volts or 230±10% volts, 50 Hz, A.C.Supply, Single phase, motors shall be provided with permanent capacitor. Motors shall be especially designed for quite operation and motor speed shall not exceed 1440 rpm.

viii. **FAN**
Fan wheels and housing shall be fabricated from heavy gauge steel. Fan wheels shall be of double-width, double inlet forward-curve, multi-blade type enclosed in a housing and mounted on a common shaft. Fan housing shall be made of die-formed steel sheets with stream-lined inlets to ensure smooth air flow into the fans, fan shaft bearing shall be oil/grease lubricated. All rotating parts shall be dynamically balanced individually, and the complete assembly shall be statically and hydraulically balanced. Fan speed shall not exceed 1000 rpm and maximum fan outlet velocity shall be 550 meters per minute.
ix. COOLING COIL

Cooling coils shall be of fin and tube type having aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and air velocity across each coil shall not exceed 100 meters per minute. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory-tested at 21 Kg. per sq.cm air pressure under water. Tube shall be mechanically / hydraulically expanded for minimum thermal contract resistance with fins. The no. of fins per cm. shall be 4 to 5.

x. VIBRATION ISOLATORS

The indoor and outdoor units shall be provided with ribbed rubber pad vibration isolators.

xi. PAINTING

Split units shall be factory finished with durable alkyd spray enamel. Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, then coated with enamel paint to match the finish over the adjoining shop-painted surface.

xii. PERFORMANCE RATING

The unit shall be selected for the lowest operating noise level. Capacity rating and power consumption with operating points clearly indicated shall be submitted with the tenders and verified at the time of testing and commissioning of the installation.

AIR COOLED SPLIT AIR CONDITIONING UNITS
(ENERGY SAVING INVERTER TYPE COMPRESSORS)

i. SCOPE

The scope of this section comprise the supply, erection, testing and commissioning of Air Cooled Split Units with inverter driven compressors conforming to these specifications and in accordance with the requirements of Drawings and Design Basic Report. The proposed unit shall meet the highest possible star rating as per BEE standards.

TYPE

The Split Units shall consist of hermetically sealed compressor, motor, air cooled condenser, strip heaters, integral refrigerant piping and wiring, all mounted on a steel frame. Indoor unit to be installed for Split Unit within building, shall be housed in insulated cabinet consisting of cooling coil, blower with motor, filter & insulated drain pan. Split unit must deliver specified capacity after taking into account loses due to piping length & site conditions.

ii. CAPACITY

The refrigeration capacity of Packaged Unit and Room Air Conditioners, split unit shall be as shown on Drawings and as per requirements.

iii. COMPRESSOR AND MOTOR

Compressor shall be hermetically sealed, swing type, serviceable type and shall have dual pressure stat, and an operating oil charge. The motor shall be suction gas cooled and shall be sealed against dirt and moisture. The motor shall be suitable for 415±10% / volts or 230±6 % volts, 50 Hz, A.C. supply.

iv. REFRIGERANT PIPING AND CONTROLS

Refrigerant piping and fittings interconnecting compressor condenser shall be all copper and valves shall be brass / gunmetal construction. The refrigerant used shall be ozone friendly HFC or any other CFC free refrigerant.
v. **CASING**

The indoor & outdoor units shall be sectionalised / cabinet construction. Indoor units shall be consisting of fan section, coil section, filter section, and drain pan. Outdoor unit shall consist of condenser coil, fan & compressor. In case of package units, the compressor shall be mounted within the indoor units and in case of split unit, the compressor shall be mounted with the outdoor units. Each section shall be constructed of thick sheet steel all welded / bolted construction, adequately reinforced with structural members and provided with sufficient access panels for proper lubrication and maintenance. Base panel shall be constructed of fabricated steel structure provided with an under frame suitably braced. Each unit shall include one piece drain pan constructed of 20 gauge galvanised sheet steel plate or stainless steel. Drain pan shall extend under coil and fan sections with drain connections. Removable panels in fan and coil sections shall provide access to all internal parts. Panels shall be internally lined with 2.5 cm thick fibreglass as per section “Insulation” for the thermal insulation and acoustic lining.

vi. **FAN MOTOR AND DRIVE**

Fan motor shall be suitable for 415 ± 10% volts or 230±10% volts, 50 Hz, A.C.Supply, Single phase, motors shall be provided with permanent capacitor. Motors shall be especially designed for quite operation and motor speed shall not exceed 1440 rpm.

vii. **FAN**

Fan wheels and housing shall be fabricated from heavy gauge steel. Fan wheels shall be of double-width, double inlet forward-curve, multi-blade type enclosed in a housing and mounted on a common shaft. Fan housing shall be made of die-formed steel sheets with stream-lined inlets to ensure smooth air flow into the fans, fan shaft bearing shall be oil/grease lubricated. All rotating parts shall be dynamically balanced individually, and the complete assembly shall be statically and hydraulically balanced. Fan speed shall not exceed 1000 rpm and maximum fan outlet velocity shall be 550 meters per minute.

viii. **COOLING COIL**

Cooling coils shall be of fin and tube type having aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and air velocity across each coil shall not exceed 100 meters per minute. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory-tested at 21 Kg. per sq.cm air pressure under water. Tube shall be mechanically / hydraulically expanded for minimum thermal contract resistance with fins. The no.of fins per cm. shall be 4 to 5.

ix. **VIBRATION ISOLATORS**

The indoor and outdoor units shall be provided with ribbed rubber pad vibration isolators.

x. **PAINTING**

Split units shall be factory finished with durable alkyd spray enamel. Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, then coated with enamel paint to match the finish over the adjoining shop-painted surface.

xi. **PERFORMANCE RATING**

The unit shall be selected for the lowest operating noise level. Capacity rating and power consumption with operating points clearly indicated shall be submitted with the tenders and verified at the time of testing and commissioning of the installation.
Refrigerant should be R-4R10A or any other CFC free refrigerant. Noise level should be less than 40Db, with wireless remote controller LCD typewith LED panel display, with sleep mode, auto restart, auto air swing(up-down), high EER Rotary, dual protection & 3M micro protection filters.

**AIR COOLED PACKAGED UNIT (INVERTER TYPE DRIVEN COMPRESSOR)**

i. **SCOPE OF WORK**

The specification for Air-cooled Package Units With Scroll Compressor covers the design requirement, constructional feature, supply, installation, testing & commissioning.

ii. **TYPE**

The Air-cooled Packaged units shall be factory fabricated and supplied with factory test certificates.

iii. **CABINET CONSTRUCTION**

The cabinet of packaged units shall be fabricated out of heavy gauge corrosion resistant sheet with powder coating / enamel. The cabinet shall have removable panels to allow easy servicing of unit, giving easy access into the unit. The fan section of the packaged unit shall be acoustically insulated at works.

iv. **COMPRESSOR**

The air-cooled packaged units shall comprise of one / two number Scroll compressor inverter driven type. The compressor section shall have all four walls acoustically insulated with 50mm thick fiberglass insulation, tissue paper & perforated Aluminium sheet to keep the sound level within 50db. The compressor should be suitable to withstand voltages varying from 340 to 460 volts.

v. **AIR-COOLED CONDENSER**

The condenser frame shall be constructed from heavy duty aluminium and incorporate a copper tube and aluminium fins coil. The coil shall be minimum of 3 rows deep, with a minimum fin spacing of 2.0 mm. The copper tubes of the condenser should be integrally firmed of minimum OD of 19 mm.

vi. **REFRIGERATION CIRCUIT**

The refrigeration system shall be of direct expansion type and shall incorporate one/ two no. hermetic scroll compressors complete with crankcase heaters.

vii. **COOLING COIL**

The cooling coil shall be constructed of rifled bore copper tubes and louvered aluminium fins, with the frame and drip trays fabricated from heavy gauge aluminium. The drip tray must be double angled for condensate flow and easily removable for cleaning. The cooling coil shall be a minimum of 4 rows deep. The distance between the fins should not be less than 1.8mm and the face velocity shall not be more than 2.5m/s.

viii. **FANS**

The fans shall be of the forward curved centrifugal type, double width, double inlet and statically and dynamically balanced. Each fan shall be driven by a high efficiency motor, through a self-tensioning belt drive arrangement. Each fan shall be mounted on a vibration isolated deck.

i. The unit shall be factory aligned, tested and complete with starter mounted inside the cabinet, refrigerant piping, complete with charging valves, thermostatic expansion valve, distributor, liquid strainer, dehydrator, liquid line shut off valve and HP/LP cut out etc. The selector switch should be concealed behind the hinged.
door and be suitable for operating the fan only or along with the cooling unit. The selector switch should be able to turn the unit on cooling and air temperature should be regulated with the thermostat which automatically starts and stops the compressor as required. In case of multiple compressors installed in one cabinet each should have independent refrigerant circuit. The blower of the packaged unit should be statically and dynamically balanced and driven by three phase motor of repute make. The air quantity of packaged unit should have at least of 400 CFM / Ton capacity.

The fan & fan motor should be able to take static pressure drop in coil, ducts, grills / diffusers. The unit should be factory wired and tested.

The air filter should have large surface and duct holding capacity which must be easily removable type for cleaning purposes.

FOR HIGH CFM PACKAGED UNIT

a) Evaporator, Condenser, Fan etc of the unit shall be designed to meet the high sensible load of the air-conditioned area.
b) Cooling coil shall have minimum four rows and fan shall be capable of delivering 500 CFM/TR.
c) Evaporator shall have large surface area as compared with normal unit.
d) Tonnage rating of unit shall be based on 35.0 deg. C ambient.

REFRIGERENT PIPING AND CONTROLS

Refrigerent piping and fittings interconnecting compressor condenser shall be all copper and valves shall be brass/ gunmetal construction. The refrigerant used shall be ozone friendly HFC-R410a or any other CFC free refrigerant.

1.7. VARIABLE FREQUENCY DRIVES FOR HVAC SYSTEMS

GENERAL REQUIREMENTS

This specification covers complete variable frequency drives (VFDs) designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD. The frequency converter shall not be a general purpose product, but a dedicated HVAC engineered product. The VFD and its options shall be factory mounted and tested as a single unit under full load before dispatch. The VFD shall be tested to UL 508C. The appropriate UL label shall be applied. The VFD shall be CE marked and conform to the European Union Electro Magnetic Compatibility directive.

TECHNICAL REQUIREMENTS

The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor de-rating.
When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor’s service factor. VFDs utilizing sine weighted/ coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.

All VFDs shall contain integral EMC Filters to attenuate Radio Frequency

The VFD's full load output current rating shall meet or exceed the normal rated currents of standard IEC induction motors. The VFD shall be able to provide full rated output current continuously

The VFD shall provide full motor torque at any selected frequency from 20 Hz to base speed while providing a variable torque V/Hz output at reduced speed.

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

An Automatic Motor Adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to perform the test.

VFD shall minimize the audible motor noise through the used of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise.

**PROTECTIVE FEATURES**

Overload protection in VFD shall automatically compensate for changes in motor speed.

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

Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition.

If the temperature of the VFD’s heat sink rises to 80C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature.

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

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

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

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

Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted.

Display shall be programmable to communicate in multiple languages including English

A Red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided.

A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD. The VFD shall also have individual Fan,

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

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

Programmable Sleep Mode shall be able to stop the VFD. When its output frequency drops below set “sleep” level for a specified time, it shall be possible to program a “wake-up” feedback value that will cause the VFD to start.

STANDARD CONTROL AND MONITORING INPUTS AND OUTPUTS:

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

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

Each relay shall have an adjustable on delay / off delay time.
Two programmable analog inputs shall be provided that can be either direct-or-reverse acting.

Each shall be independently selectable to be used with either an analog voltage or current signal.

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

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

The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting.

It shall be possible to read the status of all analog and digital inputs of the VFD through serial bus communications.

It shall be possible to command all digital and analog output through the serial communication bus.

**OPTIONAL CONTROL AND MONITORING INPUTS AND OUTPUTS**

It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.

The VFD shall automatically recognize the option module after it is powered up. There shall be no need to manually configure the module.

**MODULES MAY INCLUDE SUCH ITEMS AS:**

Additional digital outputs, including relay outputs

Additional digital inputs

Additional analog outputs

Additional analog inputs, including Ni or Pt temperature sensor inputs

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

**A REAL-TIME CLOCK SHALL BE AN INTEGRAL PART OF THE VFD.**

It shall be possible to use this to display the current date and time on the VFD’s display.
Programmable time periods, with individually selectable ON and OFF functions shall be available. The clock shall also be programmable to control start/stop functions, constant speeds,

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

Comparators for comparing VFD analog values to programmed trigger values
Logic operators to combine up to three logic expressions using Boolean algebra
Delay timers

**SERIAL COMMUNICATIONS**

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

- Metasys N2
- Modbus RTU

VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD.

**ADJUSTMENTS**

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

independent setups shall be provided.

Each setup shall have two programmable ramp up and ramp down times.

**OPTIONAL FEATURES**

All optional features shall be built and mounted by VFD manufacturer as an inbuilt factory solution.

**SERVICE CONDITIONS**

Ambient temperature at full speed, full load operation with continuous drive rated output current:

- -10 to 45°C for ratings upto 90 kW without derating
- -10 to 40°C for ratings 110 kW and higher without derating
Relative Humidity: 0 to 95%, non-condensing.

Elevation: Up to 3,300 feet without derating.

AC line voltage variation: +10% of nominal with full output.

VFD Enclosure protection: IP 55, integral, with no additional cabinets.

Side Clearances: No side clearance shall be required for cooling.

All power and control wiring shall be done from the bottom.

All VFDs shall be plenum rated.

QUALITY ASSURANCE

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

1.8. FILTERS

A. GENERAL

This section covers the general requirements for special type of filters to be installed in air moving equipment or air ducts.

B. PRE-FILTERS (FABRIC TYPE)

Synthetic fibre Pre-filters shall be in light weight aluminium framed with non woven synthetic fibre replaceable media. The filter shall have an efficiency of 90 percent down to 10 microns particles size when tested as per B.S.2831 standards. The filter frame shall be of aluminium and shall be suitable for mounting in Air handling units or ducts as required at site. The velocity across the face of the filter shall not exceed 500 FPM and the pressure drop across the filter shall not exceed 4mm. The filters shall be suitable for operation under 100 percent relative humidity and 120 deg.C temperature conditions.

C. MICROVEE FILTERS (FINE FILTERS)

Microvee filters shall be of dry type. Filters media shall be made from washable non woven synthetic fibre replaceable media reinforced with HDPE cloth & Aluminum mesh, specially treated with antifungal and bactericidal agents to prevent growth of micro organisms. The filter media shall be treated to permit washing with water several times before discharged. The media shall be properly supported and spaced so that air flow through the filter is uniform. The filter shall be housed in aluminium frame work. Filters shall be designed to remove particle down to 5 micron size and with efficiency of 98.0 percent tested as per BS 2831 using Test Dust II. The filters shall be installed in the air handling units after the chilled water coils. They shall be capable of being replaced or removed for servicing without the use of special tools.
D. HIGH EFFICIENCY PARTICULATE ABSOLUTE (HEPA) FILTERS

HEPA filters shall be made in extended surface configuration of deep space folds of sub micron glass fibers. The filter media shall be housed in an aluminium sheet frame provided with double turned flanges and closed cell neoprene gasket. The filter media shall not absorb moisture, stretch, swell or undergo chemical change with moisture. The filter shall be resistant to fungus and bacterial growth. Filters shall be free from pin holes and other leaks.

The housing shall be designed to install the HEPA filters in the terminal locations in the false ceiling or in the duct plenum so that it is removed easily without risking the infiltration of dust whatsoever. The arrangement for filters shall be strictly in accordance with the manufacturers’ recommendations and shall be approved by the engineer prior to fabrication and installation. The filters shall be protected with aluminium slotted protective grille from the bottom in case of installation of filters in false ceiling air terminals. All MS parts shall be derusted and shall be epoxy painted. The aluminium grilles shall be made from 1.6 mm aluminium sheets with minimum clear area of 60 percent. The grilles shall be anodised stove enamel painted as approved by the Engineer.

E. LAMINAR FLOW HEPA TENT:

i. INTRODUCTION

Diffusers are available for flush mounting in the ceiling. Suitable angle frames are also provided for the modular panel construction. The units are available in three standard sizes for top entry complete with opposed blade dampers.

ii. DESCRIPTION

LFD laminar flow HEPA TENT are constructed from SS-304, perforated face with approx 50% perforation. The perforated front face is openable hinge type complete with key operated dampers from front.

iii. FEATURES

- Suitable for modular panel assemblies.
- Front Faced with opposed blade dampers.
- Pivoting type face plate for damper operation from front.
- Easy maintenance and cleaning.

iv. FINISHESD STANDARD

- Epoxy Polyester Powder Coated off white/pure white.
- Natural anodised.

F. MINI PLEAT HEPA FILTERS

These filters shall remove a broad range of airborne contaminants, including fine dust, smoke soot & pollen. These filters shall increase its energy efficiency due to lower pressure drop in comparison to conventional deep pleat HEPA. The filter housing shall be with a very minimal size. The performance of the filters has to be factory scanned prior to the supply. Individual testing under rigid quality control & modern assembly methods has to be used to ensure conformance to specifications. Class of filters should be confirmed to:

- ASHRAE 52.2
- MERV Rating -16-20
- EN 1822:2009 Efficiency:- E10-H14
These filters have to be with special grade micro glass fiber paper spaced with uniformly positioned hot melt adhesive beads to ensure optimum air-flow. The filter shall be with micro glass pleated media (imported). The frame shall be with extruded aluminum or SS 304 material. It shall be of high flow box with flange. The gasket shall be polyethylene food grade. The maximum operating temperature shall be from 100 deg C to 300 deg C and the maximum humidity shall be 100% RH at 0% condensation. The initial pressure drop shall be 20 mm wg at rated air flow capacity and the final pressure drop shall be within 50 mm wg. Efficiency on 0.3 micron shall be 99.997%. The media shall be epoxy sealed & DOP tested.

ECBC Mandatory Requirements for HVAC Works - It needs to be complied with by the Contractor.

1.9. FAN COIL UNITS

A. SCOPE
This section covers the technical requirements for manufacture, testing at works, and delivering at site, testing after installation, commissioning of fan coil units conforming to these specifications and in accordance with the project requirements.

B. TYPE
The fan coil unit shall be horizontal type to be mounted within ceiling space drawn through type complete with finned coil, fan with motor (IE-3 efficiency class), double skin insulated drain pan, one or more centrifugal fans and motors, cleanable air filters & fan speed regulator & other controls as described. Horizontal fan coil units shall be provided with auxiliary secondary condensate drain pan.

C. CAPACITY
The air moving and coil capacities shall be as shown on Drawings and as per requirements.

D. CABINETS
Cabinets shall be constructed of 18 gauge die-formed cold-rolled galvanized sheet steel, bowdlerized and painted with approved shade of powder coating finish and shall have access doors to piping and controls. Access panels shall have positive locking fasteners for easy removal. Horizontal furred-in type units mounted within ceiling space shall be provided with a cabinet housing, the coil and fan section with provision to mount filters within the fan section.

E. INTERIOR CHASSIS
The interior chassis shall be constructed of not less than 16 gauge cold rolled galvanized sheet steel bowdlerized and painted with approved shade of powder coating finish. All ceiling suspended fan coil units shall be securely mounted from the building structure with top panel set dead level in both directions. In case of ceiling suspended horizontal units, fan deck and cooling coil shall be easily removable from FCU without lowering down of the FCU or disturbing the other installation.

F. FAN SECTION
This shall consist of two lightweight aluminum impellers of forward curved type, both statically and dynamically balanced. The two impellers shall be directly mounted on to a double shaft, single phase multiple winding motor capable of running at three speeds. A GI plenum shall connect fan outlet to the coil.

G. COOLING COIL
The coil shall be of seamless copper tube of minimum 10 mm OD and wall thickness shall be minimum 0.5 mm. All bends and joints shall be enclosed within insulated end sections of the base unit for protection against sweating. Each coil shall be provided with air vent. All coils shall be factory tested at 21 kg per sq.cm. (300psig) air pressure when submerged in water. Fin spacing shall be 4 to 5 fins per cm. Tubes shall be mechanically/hydraulically expanded for minimum thermal contact resistance with fins. Air vent shall be provided in headers at a level higher than coils. The cooling coil shall be easily removable from backside of FCU without disturbing the other installations. The copper tube or pipe should not be manufactured from reprocessed or recycled copper.

H. DRAIN PANS
Primary drain pan shall be of double skin construction fabricated from 22 gauge stainless steel with all corners enclosed. An additional inner bottom panel of 22 G thick stainless steel sheet shall be provided to prevent damage to insulation. The pan shall be insulated with minimum 15mm thick expanded polyethylene insulation sandwiched between top and bottom panels to prevent condensation. The pan shall be of sufficient size to accommodate cooling coil supply and return water header and bends and control valves. The auxiliary condensate drain pan shall be similar in construction to primary drain pan and size larger than primary drain pan to catch all overflows in case primary drain pan gets choked. Drain from auxiliary drain pan shall be connected to drain from primary drain pan through a tee connection and piped to vertical risers.

I. MOTOR
Motor shall be 240 ± 10% volts, 50 Hz, single phase, six poles, rpm not exceeding 1000 at maximum airflow. Motor shall have three speed windings and shall be factory wired to a terminal block mounted within the fan section. Motors shall have extended shaft on both sides. A sturdy switch shall be provided with the unit complete with wiring, for ON/OFF operation & with minimum three speed control of the fan.

J. AIR FILTER
The filter shall be cleanable type 12mm thick AL of MERV 8 rating wire mesh and mounted behind the pan in a filter plenum of GI sheet.

K. PAINTING
The fan coil units shall be powder coated in approved colour.

L. CONTROLS
All units shall be complete with following controls
• PIB Control Valve in water lines
• Wall mounted thermostat containing three speed and on/off control for fan, speed and temperature control for summer/ winter air conditioning
• 'Y' strainer, ball valve and globe valve as shown on drawings and as per requirements.

M. PERFORMANCE DATA
Fan coil units shall be selected for the lowest operating noise level having standard sound level rating of NC 30 at low speed and NC 35 at medium / high speed. Fan performance rating and power consumption data, with operating points clearly indicated, shall be submitted by the Contractor and verified at the time of testing and commissioning of the installation.

N. TESTING
Cooling capacity of various fan coil unit models shall be computed from the measurements of airflow and dry and wet bulb temperatures of entering and leaving the coil. Flow measurements shall be by anemometer and temperature measurements by accurately calibrated mercury -in-glass thermometers. Computed ratings shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

O. DATA / INFORMATION
The contractor shall complete the Data Sheet & submit as a part of his technical submittal at appropriate stage.

ULTRASONIC HUMIDIFIER
Scope of Work
This section deals with supply, installation, testing and commissioning of Ultrasonic Humidifier to be supplied as mentioned in Detailed Schedule of Quantities
Constructional Feature
The Humidifier shall be Horizontal Floor standing with casters. The tank shall be constructed out of 1.2mm thick SS-304 Sheet. Control Panel made out of 1.2mm thick CRCA sheet duly powder coated.
Controls & Accessories
The Ultrasonic Humidifier will be provided and not limited to following controls & accessories
a) Water filter membrane and Air filter assembly
b) Level switches for upper and lower water level
c) Piezo transducers with Low water level protection.
d) Solenoid operated Water makeup/Fill
e) Drain Valve
f) Water Overflow connection with valve
g) Mist outlet point
Power Supply
Suitable for 1Phase, 230VAC +5% regulated power supply upto 30LPH and above 30LPH suitable for 3Phase, 415VAC +5% Electrical Control Panel for Ultrasonic Humidifier
The electrical control panel shall be mounted directly on the main frame confirming to standard specification of Indian Electricity Rules. All controls shall be factory wired & tested. The control panel shall have the following Accessories of makes mentioned in makes of components section.

a) Incoming MCB
b) On/Off Switch with light
c) Step down transformer/Power supply unit
d) Power Contactor
e) Ventilation fan
f) PVC insulated copper cabling for power and control circuit.

1.10. VENTILATION SYSTEM
The ventilation fan shall be complete in all respects and shall generally comply with the following specifications given below:

A. INLINE FANS
2.1 GENERAL
The inline fan shall be complete in all respects and shall comply with the following specifications:

2.2 FANS
The fan shall be complete with centrifugal impeller, casing, direct driven motor, vibration isolators etc.

2.3 HOUSING
The housing shall be constructed of hot rolled GSS sheet metal construction. Housing metal shall be either spot welded or screwed or mounted together with the rivets. The housing shall indicate arrow showing rotation, make, model and duty condition.

2.4 FAN WHEEL
Fan wheel shall be forward/backward curved type and it shall be statically and dynamically balanced.

2.5 BALL BEARING
The ball bearing shall be completely maintenance free and can be used in any mounting position at maximum indicted temperature. The bearing lubricant shall be suitable for min. ambient temperature of 15°C. For applications at max. Indicated ambient temperature life expectancy L10 is 40,000 hours minimum.

B. INLINE & PROPELLER FANS
a) SCOPE
The scope of this section comprises the supply, installation, testing and commissioning of centrifugal and inline fans conforming to these specifications and in accordance with the requirement of drawings and BOQ.

b) TYPE
Centrifugal and inline fans shall be of type as indicated in drawings and in BOQ.

c) **INLINE FANS**

Inline fan shall incorporate DIDW direct driven centrifugal fan with TEFC (IP-21/44) motor or as per OEM. It should be preferably AMCA certified. The Fan RPM shall not be exceeding 1440. The fan assembly shall be enclosed in a sheet metal housing of 22 gauge GSS and with necessary inspection cover with proper gasket assembly.

The fan material shall be galvanized sheet steel. Flanges shall be provided on both sides of inline fan to facilitate easy connection. Flexible anti-vibration joints shall be provided to arrest vibration being transferred to other Equipments connected to inline fan. Motor shall be single phase/three phase as per duty conditions.

All single-phase fans shall be provided with speed regulators while all three phase fans shall be provided with opposed blade dampers in GSS construction at fan outlet for air balancing.

d) **PROPELLER FANS**

Propeller fans shall be direct driven, three or four blade type mounted on a steel mounting plate with orifice ring.

Mounting plate shall be of steel construction, square with streamlined venturi inlet coated with baked enamel paint. Mounting plate shall be of standard size, constructed of 12 to 16 gauge steel sheet depending upon the fan size. Orifice ring shall be correctly formed by spinning or stamping to provide easy passage of air without turbulence and to direct the air stream.

Fan blades shall be constructed of aluminum or glass reinforced polypropylene. Fan hub shall be of heavy welded steel construction with blades bolted to the hub fan blades and assembly shall be statically and dynamically balanced.

Shaft shall be of steel accurately ground and shall not pass through first critical speed through entire range of specified fan speed. Motor shall be standard permanent split capacitor of shaded pole for small sizes, totally enclosed with pre-lubricated sleeve or ball bearings, designed for a quiet operation with a maximum speed of 1000 RPM for fans 60 cm dia. or larger and 1440 RPM for fans 45 cm dia. and smaller.

Motors for larger fans shall be suitable for 415 ± 6% volts. 50 cycle 3-phase power supply and for smaller fans shall be suitable for 220 ± 6% volts, 50 cycles single-phase power supply. Motors shall be suitable for horizontal or vertical service as indicated in drawings and as per requirements.

Propeller fans shall be provided with following accessories:
- Wire guard and bird-screen
- Gravity louvers at outlet
- Regulator for controlling fan speed for single-phase fan motor.
- Single-phase preventors for 3 phase fans.
- Wiring between regulator and fan motor including termination at both ends.

e) **PERFORMANCE DATA**

All fans shall be selected for the lowest operating noise level. Capacity rating, power consumption with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of installation.
f) TESTING

Capacity of all fans shall be measured by an anemometer. Measured airflow capacities shall conform to the specified capacities and quoted ratings, power consumption shall be computed from measurements of incoming voltage and incoming current.

The Fans shall be preferably AMCA certified. Also, it should be UL & FM/EN approved.

C. CENTRIFUGAL FAN SECTIONS

a) SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of ventilation fan sections conforming to these specifications and in accordance with the requirement of drawings and BOQ. Fan Outlet velocity shall not exceed 610 meters per minute.

b) TYPE

Ventilation fan sections shall be complete with Centrifugal Fans, belt driven fans complete with motor drive and housing with weatherproof cowl.

c) UNIT CONSTRUCTION

i. HOUSING

The housing shall be fabricated out of 16 gauge steel sheet and shall have flange to be connected to duct. The discharge cowl shall be hinged along one edge for easy access to motor and drive, for inspection and maintenance. The entire assembly shall be weatherproof and provided with 18 gauge galvanized steel mesh bird screen of 6 mm size on all discharge cowls around the outlet areas. Shaft shall be constructed of steel, turned, ground & polished.

ii. FAN

Fan shall be forward / backward inclined wheel type designed for maximum efficiency, minimum turbulence and quiet operation. Fan shall be statically and dynamically balanced. Fan shall conform to specifications as given in specification No.SPC/CF – PF/01.

iii. MOTOR

Motors shall be suitable for 415 + - 10% volts, 50 CPS, 3 Phase AC supply totally enclosed fan cooled motor provided with class ‘F’ insulation & IE-3 class efficiency. Motor shall be designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be through belts.

iv. BACK DRAFT DAMPER

Where called for in BOQ the ventilation fan section shall be provided with a rattle free back draft damper to prevent air from re-entering the fan when fan is not in operation, thus sealing completely in closed position. Damper shall be chatterproof under all conditions.

d) VIBRATION ISOLATION

The motor and fan assembly shall be isolated from base through Dunlop/Resistoflex vibration isolators.
e) **PERFORMANCE DATA**

All fans shall be selected for the lowest operating noise level. Capacity rating, power consumption with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of installation.

f) **TESTING**

Capacity of all fans shall be measured by an anemometer. Measured airflow capacities shall conform to the specified capacities and quoted ratings, power consumption shall be computed from measurements of incoming voltage and incoming current.

The Fans shall be AMCA certified. Also, it should be UL & FM/EN approved. Sound attenuators with/without baffles to reduce noise generated at source itself wherever feasible.

D. **AXIAL FLOW FAN SECTIONS**

a) **SCOPE**

This section covers the technical requirements for manufacture, testing at works, delivery at site, testing after installation, commissioning of axial flow fan equipments for ventilation and exhaust system. Their location shall be as given in BOQ and drawings.

The fans shall be complete with all the accessories required for proper installation and performance consisting mainly of the following:

- Suction and discharge side flanges and counter flanges suitably drilled, complete with bolts & nuts, direct driving electric motor, suspension hangers (for ceiling hung fans only) for vibration isolation (rubber in shear type).
- Any structural steel and hardware required for assembly, installation, supporting of fan or accessories. 2 mm thick flexible connectors, fire resistant type at suction and discharge end, Foundation bolts and vibration isolators (in case of floor mounting only).
- Gravity louvers

b) **APPLICABLE SPECIFICATIONS STANDARDS AND CODES.**

Documents listed below should be read along with the technical data given in the BOQ and shall be applicable to the material, manufacture, testing and installation of axial flow fans and accessories.

- ANSI/ASHRAE: standard 51
- IS-2312 – Propeller type A.C ventilation fans
- BS – 848/ ACMA Tested – Methods of performance test for fans

c) **DESIGN & MANUFACTURING**

i. **FAN AND COMPONENTS**

- The fan shall be designed to handle the quantity of air against the static pressure and at conditions indicated in the technical data. The fan shall have 70%
efficiency or nearest possible (best) available at OEM’s end at operating conditions and shall have performance characteristics to match the approved performance curves.

- The unit shall be factory built to the highest standards to ensure rigidity, maximum mechanical and electrical reliability, quite, stable and vibration free operation at the prescribed conditions of flow, static and speed.
- The casing shall be fabricated from heavy gauge sheet steel with suction and discharge ends flanged and complete with counter flanges, G.I. nuts and bolts. The flanges and counter flanges shall be matched and drilled suitably to receive flexible PVC connections. An inspection door with handle and neoprene gaskets shall be provided. Support brackets for ceiling suspension shall be bolted to the casing for connection to hanger bolts.

ii. IMPELLER & BLADES
The impeller shall be cast aluminum; aerofoil type with well-balanced blades made from cast aluminum alloy or cast steel construction.

d) DRIVE
The fan hub and blades shall be directly mounted on the shaft of a totally enclosed motor, rotor of fan motor shall be well balanced. The motor shall be TEFC, squirrel cage, IP 55 0–class H/F as per use, IE-3 class efficiency preferably and suitable for 415 ± 10% V, 50 HZ 3 phase AC power supply. The motor shall be dual speed wherever called for in BOQ. The maximum motor speed shall be limited to 1450 RPM. Motor conduit box shall be mounted on exterior of fan casing and lead wires from motor to conduit box shall be protected from air stream by enclosing in a flexible metal conduit.

e) TECHNICAL SPECIFICATIONS
The firm shall submit the technical data and performance characteristics with operating points duly marked for approval prior to fabrication. The supplier shall supply the test certificates of all the fans.

f) GENERAL REQUIREMENTS
- Static, dynamic balancing and vibration: the individual fan impeller, blades, motor shall be statically and dynamically balanced independently. After assembly the entire fan motor unit shall not give rise to any vibrations. The balancing shall be as per ISO: 1940 GR 6.3.
- NOISE LEVEL: The tendered shall indicate the noise level generated by the fan/motor unit in terms of decibel units to be measured at 3 meter from the unit. This shall fall in line with best engineering standard and shall not be more than 80 db.

g) PAINTING
All fans and their accessories shall be painted with two coats of suitable enamel paint after one coat of Red Oxide primer.

h) PACKING
The fans shall be dispatched in packed condition to avoid damage during transportation to site. Transit insurance for the fans shall be included in this offer.

i) INSPECTION & TESTING
All fans shall be subjected to inspection and testing requirements as given below. The contractor shall be responsible for providing all inspection facilities and for conducting all tests at works and at site after erection. Test certificates for all fans shall be submitted, some fans at the discretion of CLIENT/ HITES may be tested at the factory in his presence.

The performance of the fan motor unit shall be tested by operating at design conditions. The following parameters will be tested vis-à-vis the approved performance curves.

Airflow capacity, Static head developed, BHP requirement, Vibration and noise level. The Fans shall be AMCA certified. Also, it should be UL & FM/EN approved. Sound attenuators with/without baffles to reduce noise generated at source itself wherever feasible.

### 1.16 SHEET METAL WORK & AIR DISTRIBUTION

#### A. SCOPE

The scope of work shall include supply of factory fabrication of G.I. sheet metal duct and its installation as shown in the relevant duct drawing, testing at site, loading & unloading of G.I. sheet ducts at site, and shifting and other hardware from site stores to exact location inside the office complex. The packing shall be suitable for marine transportation purpose and all other natural disasters and the same shall be transported to respective office warehouses to achieve a guaranteed commercial operation of the same to the entire satisfaction of client.

#### B. RAW MATERIAL

Galvanizing shall be uniform coating of zinc on both sides (total) of 275gm/sq.m and Lock forming quality prime material along with mill test certificates. In addition, if deemed necessary, samples of raw material selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

#### C. DUCT MATERIALS

The ducts shall be fabricated from galvanized steel sheets class VIII - Light coating of Zinc conforming to ISS: 277-1962 (REVISED) and with a galvanizing thickness of nominal 120 gm. per SQM surface area.

Only new, fresh, clean (unsoiled) and bright GI/Aluminum sheets shall be used. The CLIENT/ HITES reserve the right to summarily reject the sheets not meeting these requirements. Fabrication of ducts shall be through Lock forming machines.

All duct work, sheet metal fabrication unless otherwise directed, shall strictly meet requirements, as described in IS:655-1963 with Amendment-I (1971 Edition)

<table>
<thead>
<tr>
<th>Longer size of Duct (mm)</th>
<th>Sheet Thickness GI (mm)</th>
<th>Type of Joints</th>
<th>Bracing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 750</td>
<td>0.63</td>
<td>GI Flange</td>
<td>-</td>
</tr>
<tr>
<td>751 to 1000</td>
<td>0.80</td>
<td>25x25x3 mm angle iron frame with 8 mm Dia nuts &amp; bolts</td>
<td>25X25X3 MM @ 1M</td>
</tr>
<tr>
<td>1001 to 1500</td>
<td>0.80</td>
<td>40x40x5 mm angle iron frame with 8 mm Dia nuts &amp; bolts</td>
<td>40x40x5 MM @1M</td>
</tr>
</tbody>
</table>
Tender No. HITES/IDN/DRUG-LAB/KATHUA/2019-20

Page 351

**Construction of Drug Testing Laboratory, Kathua (J&K)**

**Volume IV Technical Specifications**

| 1501 to 2250 | 1.00 | 50x50x5 mm angle iron frame with 10 mm Dia nuts & bolts at 125 mm center | 40x40x3 mm @ 1.2m to be braced diagonally. |
| 2251 & above | 1.25 | 50x50x6 mm angle iron frame with 10 mm Dia nuts & bolts at 125 mm center | 40x40x3 mm @ 1.6m diagonally braced |

- Ducts larger than 450 mm shall be cross broken, duct sections up to 1200 mm length may be used with bracing angles omitted.
- Changes in section of ductwork shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 Deg. Angle from the axis of the main duct unless otherwise approved by the Engineer-in-Charge.
- All ducts shall be supported from the ceiling/slab by means of M.S. rods of 10 MM Dia with M.S. angle at the bottom of size 40 mm x 40 mm x 6 mm for sizes up to 1500 mm at 3 m intervals. Above size 1500 mm upto 2250, support shall be provided with 10 mm dia. MS rod and MS angle size 50 mm x 50 mm at bottom at 2.5 m intervals. Above size 2250 mm support shall be provided with 12 mm dia MS rod and MS angle size 50 mm x 50 mm at bottom.

**D. GAUGES, BRACING BY SIZE OF DUCTS**

All ducts shall be fabricated from galvanized steel/aluminum of the following thickness, as indicated as below:

- For Rectangular ducts shall with external SP up to 250 Pa (25mm Wg)
- Sealant dispensing equipment for applying built-in sealant in Pittsburgh lock where sealing of longitudinal joints are specified.
- All transverse connectors shall be 4 bolt slip-on flanges system with built-in sealant.
- Duct construction shall be slip-on flange in compliance with 1” (250Pa) w.g. static norms as per SMACNA. Important to note is Slip-on flanges system should have 3rd party testing & certification.

### FOR SELECTION OF 4 BOLT SLIP-ON FLANGE CLASS AND DUCT GAUGES AT 1200 MM SPACING

<table>
<thead>
<tr>
<th>Duct Dimension (in)</th>
<th>Duct Pressure in Inches / (Pascals)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1&quot;(250)*</td>
</tr>
<tr>
<td>150 – 250</td>
<td>E-26</td>
</tr>
<tr>
<td>251 – 300</td>
<td>E-26</td>
</tr>
<tr>
<td>301 – 350</td>
<td>E-26</td>
</tr>
<tr>
<td>351 – 400</td>
<td>E-26</td>
</tr>
<tr>
<td>401 – 450</td>
<td>E-26</td>
</tr>
<tr>
<td>451 – 500</td>
<td>E-26</td>
</tr>
<tr>
<td>551 – 600</td>
<td>E-26</td>
</tr>
</tbody>
</table>
### E. FABRICATION STANDARDS & 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:

- A coil (Sheet metal in Roll Form) line 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.
- All ducts, transformation pieces and fittings to be made on CNC profile cutters for required accuracy of dimensions, location and dimensions of notches at the folding lines.
- All edges to be machine treated using lock formers, flangers and rollers for turning up edges.
- Kitchen exhaust ducting shall be with 16 G MS suitable access doors shall be provided at every 3 m. Provision shall be made for firefighting agency to install duct mounted sprinklers at every 3m. Generally exhaust duct shall have slop towards kitchen hood.

### F. DUCT CONSTRUCTION

All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA codes:

<table>
<thead>
<tr>
<th>Size Range</th>
<th>E-26</th>
<th>E-26</th>
<th>E-24</th>
<th>F-24</th>
<th>H-22</th>
<th>H-18</th>
</tr>
</thead>
<tbody>
<tr>
<td>651 – 700</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>701 – 750</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>751 – 900*2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>901 – 1000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1001 – 1200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1201 – 1300</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1301 – 1500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1501 – 1800</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1801 – 2100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2101 – 2400</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2401 – 2700</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

- SMACNA- Sheet Metal and Air conditioning Contractors’ National Association Inc.
  “HVAC Duct Construction Standards-MetalandFlexible”-2005, U.S.A.
- For non-critical comfort cooling applications (1” w.g. pressure class), optional “C & S” or “C & SS” cleat joints can be used.
- Upto 450 mm duct size: use “C & S” cleats.
- 451 to 750 mm duct size: use “C & SS” cleats.
- Over 750 mm duct size: use 4 bolt Slip-on flanges.
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 dimension shown in the 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.

- Ducts shall be straight and smooth on the inside with longitudinal seams shall be air either Pittsburgh or snap button as per SMACNA practice, to ensure air tightness.
- All ducts up to 75 cms 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 ensure that S/SS cleats are mounted on the longer side of the duct and cleats on the shorter side. Ducts more than 75cms width shall have 4 bolt slip-on flanges. Ducts and accessories within the ceiling spaces, visible from air-conditioned areas shall be provided with two coats of mat black finish paint.
- Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Air-vanes shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.
- Ducts shall be fabricated as per details shown on drawings. All ducts shall be rigid and shall 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.
- All sheet metal connections, partitions and plenums required to confine the flow of air to and through the filters and fans, shall be constructed of 18G GSS/16G 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 45cm x 45cm in size.
- Plenums shall be shop/factory fabricated panel type and assemble at site. Fixing of galvanized angle flanges on the duct pieces shall be with rivets heads inside i.e. towards GS sheet and riveting shall be done from outside.
- Self-adhesive Polyethylene lining of minimum 4.5mm thickness instead of felt shall be used between duct flanges and between duct supports in all ducting installation.

G. ACCESSORIES

- All dampers, except where shown, shall be louver dampers having multiple opposed blades type or with parallel blades of airfoil construction. The construction of the dampers shall be robust and tight fitting. They should be made from 18 gauge galvanized sheets. The depth should be minimum of 150mm and flanges of 40mm. Blades shall be connected with a suitable linkage for operation by an extending by an extending lever, which shall have a locking quadrant with positions of the damper indicated on it. Dampers and their operating device shall be made robust, easily operable and accessible through suitable access doors in the ducts.
- Dampers shall be provided in ducts at every branch supply or return air duct connections whether or not indicated on the drawings for the proper volume control and balancing the system.
• Where shown, splitter dampers shall be installed. This damper consists of double thickness airfoil blade hinged on the downstream edge. The operating lever shall extend outside the duct and insulation with an airtight hub and locking arrangements. The thickness of the damper blades shall be the same as the duct in which they are installed but not less than 1.5mm thickness.

• Fire dampers shall be motorized / solenoid type wherever specified shall be provide in the ducts to minimize spreading of fire through ducts, i.e. points where duct passes fire (rated 1 ½ hrs. or more) wall or slab. Fire dampers shall be 230mm – deep and face area as required. The outlet casing of the damper shall be fabricated out of 12 gauges M.S. sheet duly epoxy painted with two coats. The louvers shall be provided with smooth pivoted linkage, tripping mechanism of steel bar with heavy-duty spring assembly and provision of motor. The louvers to be arranged to pivot and hold in an open position and can be closed by an electrically operated motor. The damper is used in conjunction with a smoke alarm system. The entire assembly shall be duly epoxy primer of 2 coats (epoxy paint) or aluminum spray painted. The dampers shall be designed for automatic as well as manual tripping.

• Motors shall be rated for fire damper (spring to close power to open) operation and shall be suitable for outdoor installation (IP55). Fire dampers are closed on a signal from the fire control module. Module supply and wiring by fire control contractor.

• Motorised dampers should be single flap dampers with 18 gauge construction with Belimo or Equivalent make spring return type. Opening time should be more than 75secs. And closing time should be 30secs. The power shall be given from the electrical panel and will be routed through the unit.

• 300mm X 300mm access panels with gasket neoprene and stud bolt type shall be provided near lower dampers/ splitters dampers and fire damper. All main ducting work shall be accessible throughout using tight fitted hinged access doors. Doors shall be cemented sponge rubber gaskets of 6mm thickness. Felt is not acceptable. In the case of insulated ducts with access doors, the same shall be properly insulated, such that it can be operated without damaging the duct insulation and there should be no condensation either on the access doors or on the ducts when he plant is running.

H. INSTALLATION GUIDELINES

• The duct fabrication and installation shall generally confirm to IS 655-1963.

• All ducts shall be supported from the concrete slab or beams. Duct supports shall be fixed through the use of two anchor fasteners for each leg. The anchor fasteners shall be of approved make. If ducting is supported from steel structure, Beam Clamps shall be provided. In no case shall the duct be supported from the false ceiling hangers or be permitted to rest on a hung ceiling.

• Transverse joints shall be provided with rubber gaskets (6mm thk.) of nonflammable type. Use of felt shall not be permitted.

• Wherever the ducts are acoustically lined, the duct size shall be increased by the thickness of the duct lining.

• The contractor shall provide and neatly erect all sheet metal work as per the specifications and drawings. This work, in all its parts and details, shall meet with the approval of the Engineer.

• The contractor shall make all necessary allowances and provisions for beams, pipes or other obstructions in the ducting, whether or not the same has been shown in the
drawings. Wherever necessary to avoid beams or other structural works, plumbing or other pipes / conduits, the ducts shall be transformed, divided or curved to one side as approved or directed by the Engineer. However the required cross-sectional area shall be maintained.

- All metal work shall be done in dead or furred down spaces so as not to cause any delay to other contractors on the building.
- If a duct cannot be installed as shown in the drawings, the contractor shall install the duct between the required points by any path available subject to the approval of the Engineer and Architect.
- All ducts shall be rigid and shall be adequately supported with standing seams, tees or angles of ample size wherever required to keep the ducts true to shape, prevent buckling, vibration and breathing.
- All duct joints shall be tightly fitted using rubber gasket of nonflammable type and all interior surfaces shall be smooth. Bends shall be made with radius not less than one-half of the width of the duct or with properly designed interior curved vanes. Two vanes shall be spaced such that the aspect ratio of each of the individual elbows formed by the vane will be about five to one.
- All sheet metal connections, partitions and plenums required to confine the flow of air to and through the filters and fans, shall be constructed from 16G galvanised iron thoroughly stiffened with 25mm X 25mm angle iron braces and fitted with all necessary doors as required to give access to all parts of the apparatus. Doors shall not be less than 46 cm X 71cm. Sheet Metal connections to indoor units shall be flexible, double thickness fiberglass cloth or equivalent nonflammable material of 100mm long.
- Where metal ducts or sleeves terminate in woodwork, brick or masonry openings tight joints shall be made by the means of closely fittings heavy flanged collars.
- Resistoflex or similar vibration isolation material of 6mm thickness shall be provided between ducts and duct support.
- Where ductwork is connected to rotating equipment duct such as fans, air handling units (indoor unit of split/package system), the connections shall be made with double thickness nonflammable flexible material, 100mm long.

I. GRILLES AND DIFFUSERS

- **Supply Air Side Wall Outlets:** Wherever specified in the B.O.Q. shall be in Aluminum construction.
- **Double Deflection Grilles:** Wherever specified in the B.O.Q. shall be in Aluminum construction. Aluminum double deflection grills for supply air shall be provided with vertical and horizontal adjustable bars and an approved blade damper adjustable from the front face of the grille. The grilles will be powder coated in a shade as given in the schedule of finishes of this handbook.
- **Fixed Bar Linear Grilles:** Fixed bar grilles will be in extruded aluminum construction. Bars shall be fixed in position using vertical tie bars. Bar spacing shall not exceed 12mm and the grilles shall have 60% free area. Deflection angle of the bars shall be 0. The grilles will be powder coated in a shade as per the owner/architect. Irrespective of grille finish, vertical tie bars shall be powder coated in Matt black. Supply air outlets shall be provided with volume control dampers to be installed in the duct collar. Dampers shall be in black Matt powder coated finish. Where required by the Architects/Consultants, the grilles shall be provided with a margin on all sides.
Supply air outlets shall be provided with end closure pieces for the supply portion of the grille. The end closure pieces shall not come to the grille face. Continuous grilles shall butt with hairline joints and be provided with interlocking splines. All return air grilles shall be similar and equal to the above as determined by consultants. All exhaust air grilles shall be similar and equal to the supply air grilles specified above.

J. SQUARE / RECTANGULAR DIFFUSERS/ CEILING OUTLETS
- Shall be of aluminum construction wherever specified in the BOQ. Corners of inner and outer cores shall be assembled to provide precise mitered corners.
- Supply air diffusers shall be provided with multi blade butterfly dampers. Damper flaps shall be provided with a nylon worm gear assembly for ease of operation.
- Diffusers will be powder-coated in a shade as approved by client/Architect. Diffuser shall be half step down type.

K. GUIDELINES FOR INSTALLATION OF GRILLES/DIFFUSERS
- Installation of the grilles/diffusers shall be done by the air conditioning contractor irrespective of the type/model of false ceiling systems. The diffusers will have to be individually suspended from the duct and aligned to match the ceiling line level. In case gypsum or any other false ceiling system, all wooden frames, rectangular or circular for supply/return/exhaust air diffusers will be provided by the Air conditioning contractor.
- All air outlets/return air inlets in the same room shall be of the same size unless otherwise specified.
- Grilles and diffuser samples must be submitted to the consultants for prior approval before procurement and installation.
- Wire Hangers shall be used to suspend all static HVAC services. Wire Hangers should consist of a pre-formed wire rope sling with a range of end fixings to fit 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.
- 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.
- The contractor shall select the correct wire hanger to use for supporting each particular service from table 1 below. Each size is designated with a maximum safe working load limit (which incorporates a 5:1 safety factor).
- The correct specification of wire Hanger required is determined using the following formula.
• Weight per meter of object suspended (kg) × distance between suspension points (m) = weight loading per Hanger suspension point (kg).
• Where the installed wire rope is not vertical then the working load limit shall be reduced in accordance with the recommendations give in the manufacturer’s handbook.
• The contractor shall select the correct length of wire rope required to support the service. Lengths from 1-10m lengths. Specials can be made, check with manufacturer. No in-line joints should be made in the rope.

**TABLE. 1**

<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. Note the testing is done to the minimum breaking load of the wire thus giving a minimum safety factor of 5: 1.

**L. DUCTING SUPPORTS**
All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with hangers formed of galvanized steel wire ropes and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel wire hangers under ducts, rigid supports may be provided at certain interval if need be. The spacing between supports should be not greater than 2.4 meter.
All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates or Toggle end wire fixing left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the wire rope hanger shall be welded to the plates. Trapeze hanger formed of galvanized steel wire rope 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.

All horizontal ducts shall be adequately secured and supported. In an approved manner, with trapeze Hangers formed of galvanized steel wire rope in a cradle support method (refer to typical drawings) under ducts at no greater than 2000mm centre, for above 2000-2250mm 50x50x5 mm angle should be used under the duct (refer to typical drawings), above 2250 mm appropriate size 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.

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.

M. PIPING SUPPORTS

Rigid supports may be used in conjunction with Gripple hangers to assist with alignment of services as per the Schedule II. These can be at 30m intervals or so depending on the run of the service. Rigid support must also be used in conjunction with Gripple hangers with pipe work at each change of direction or connection. For insulated pipe, provide protective sleeve to protect the entire circumference of the pipe insulation. Stainless Steel Supports should be available for food, chemical and High Corrosion areas near coastlines.

Any other Gripple solution can be used based on manufacturer’s recommendation on site conditions after prior approval. Support piping in accordance with Schedule II at the end of this Section.
### 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>
<tr>
<td>2401-2700 mm</td>
<td>18</td>
<td>4</td>
</tr>
</tbody>
</table>

### PIPE HANGER SCHEDULE

<table>
<thead>
<tr>
<th>Pipe Size (mm)</th>
<th>Weight of pipe + fluid with insulation (kgs/rmts)</th>
<th>Weight of pipe + fluid per Rmt with sand cement plaster (kgs/rmts)</th>
<th>Spacings between supports (mts)</th>
<th>Spacings between supports (mts)</th>
<th>Total Weight of pipe + fluid with insulation (kgs/rmts)</th>
<th>Total Weight of pipe + fluid with sand cement plaster (kgs/rmts)</th>
<th>Gripple Hanger No.</th>
<th>Gripple Hanger No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-32</td>
<td>11.73</td>
<td>14</td>
<td>1.5</td>
<td>1.5</td>
<td>18</td>
<td>21</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>40-65</td>
<td>11.73</td>
<td>14</td>
<td>2</td>
<td>2</td>
<td>23</td>
<td>28</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>80-125</td>
<td>34.73</td>
<td>41.67</td>
<td>2</td>
<td>2</td>
<td>69</td>
<td>83.34</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>150-250</td>
<td>112</td>
<td>134</td>
<td>2</td>
<td>1.5</td>
<td>224</td>
<td>201</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>300 - 350</td>
<td>180</td>
<td>215</td>
<td>1.5</td>
<td>1.5</td>
<td>270</td>
<td>322.5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>400-500</td>
<td>320</td>
<td>383</td>
<td>1.5</td>
<td>-</td>
<td>480</td>
<td>-</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>600-above</td>
<td>as per the manufacturer recommendation and with prior approval</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### RIGID SUPPORTS FOR PIPES TO BE USED IN CONJUNCTION WITH WIRE SUPPORTS:

Tender No. HITES/IDN/DRUG-LAB/KATHUA/2019-20 Page 359
### Pipe size | Rod Size
---|---
Upto 12 mm | 10 mm
15 to 25 mm | 10 mm
30 to 150 mm | 10 mm
Over 150 mm | 12.5 mm

N. DUCT ACOUSTIC LINING

1. OPEN CELL NITRILE RUBBER

- Duct acoustic lining material shall be Nitrile Rubber open cell foam. Thermal conductivity of the insulation material shall not exceed 0.047 W/mK at an average temperature of 20°C. Density of the nitrile rubber shall be 140 – 180 Kg/m3. The material should withstand maximum surface temperature of +85°C and minimum surface temperature of -20°C. The material should conform to Class 1 rating for surface spread of Flame in accordance to BS 476 Part 7 & HBF, HF 1 & HF 2 in accordance to UL 94, 1996.
- Insulation should have antimicrobial product protection, and should pass Fungi Resistance as per ASTM G 21 and Bacterial Resistance as per ASTM E 2180. The insulation should pass Air Erosion Resistance Test in accordance to ASTM Standard C 1071-05 (section 12.7).
- Thickness of the material shall be 15 mm thick specified for the individual application and with noise absorption proprieties as per IS: 8225 / ISO 354 /ASTM423C. The insulation should be installed as per manufacturer’s recommendation.

2. MEASUREMENT OF INSULATION

Unless otherwise specified measurement for duct and pipe insulation for the project shall be on the basis of center line measurements described herewith:

- Pipe Insulation shall be measured in units of length along the centre line of the installed pipe, strictly on the same basis as the piping measurements described earlier. The linear measurements shall be taken before the application of the insulation. It may be noted that for piping measurement, all valves, orifice plates and strainers are not separately measurable by their number and size. It is to be clearly understood that for the insulation measurements, all these accessories including cladding, valves, orifice plates and strainers shall be considered strictly by linear measurements along the centre line of pipes and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.
- Duct Insulation and Acoustic Lining shall be measured on the basis of surface area along the centre line of insulation thickness. Thus the surface area of externally thermally insulated or acoustically lined be based on the perimeter comprising centre line (of thickness of insulation) width and depth of the cross section of insulated or lined duct, multiplied by the centre-line length including tapered pieces, bends, tees, branches, etc. as measured for bare ducting.

O. DUCT THERMAL INSULATION

- Thermal insulation material for Duct insulation shall be with factory laminated black fiber glass cloth closed cell Elastomeric UV resistant or plain polyethylene material. Thermal conductivity as per BS 874 part 2 - 86 (DIN 52613 52612) / DIN EN 12667 / EN ISO8497 of the insulation material shall not exceed 0.038 W/moK or 0.212 BTU / (Hr-ft2-oF/inch) at an
average temperature of 30oC. Density of the nitrile rubber shall be 40-60 Kg/m3 & for polyethylene material it shall be 25-30 Kg/m3 and shall be plain material. The product shall have temperature range of –40 oC to 105oC.

**• The insulation material shall be fire rated for Class 0 as per BS 476 Part 6 : 1989 for fire propagation test and for Class 1 as per BS 476 Part 7, 1987 for surface spread of flame test. Water vapour permeability shall be not less than 0.024 per inch (2.48 x 10-13 Kg/m.s.Pa i.e. μ>7000: Water vapour diffusion resistance) as per DIN 53122 part 2, DIN 52615 / EN 12086 & EN13469.**

**• In addition to above properties the insulation material for ducts shall be anti-microbial. Microbiological growth on insulation surface shall be in accordance with ASTM G-21 and bacterial resistance to ASTM2180.**

**• The Material shall comply to ISO 5659 / BS 6853 / ABD 0031 for smoke density and toxicity values. The thermal conductivity of insulation material shall not be effected by aging as per DIN 52616 standard.**

**• Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer's test certificate for density and thickness. Samples of insulation material from each lot delivered at site may be selected by Owner's site representative and gotten tested for thermal conductivity and density at Contractor's cost. Adhesive used for sealing the insulation shall be non-flammable and with low VOC content (maximum 850 gm/l as per IGBC guide lines) strictly as per manufacturer's recommendations.**

**• External thermal insulation shall be provided as follows :**

**• The thickness of insulation material shall be as shown on drawings or identified in the schedule of quantity. Following procedure shall be adhered to:**

**• Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work.**

**• Measurement of surface dimensions shall be taken properly to cut closed cell insulation to size with sufficient allowance in dimension. Cutting of insulation sheets shall be done with adjustable blade to make 90° cut in thickness of sheet. Hackshaw or blades are not acceptable tools for cutting the insulation.**

**• Material shall be fitted under compression and no stretching of material shall be permitted. All longitudinal and transverse joints shall be sealed by providing 50 mm wide Fibre glass cloth laminated tape as per manufacturer recommendations. The insulation installers shall be certified by manufacture.**

**• Where ducts/pipes penetrates walls / floor it shall be insulated with intumescent properties insulation material for fire protection. The treatment shall be minimum 500 mm extended on both sides.**

**DUCTING INSULATION THICKNESS SHALL BE AS PER TABLE BELOW.**

<table>
<thead>
<tr>
<th>Ducting position</th>
<th>Thk. for non-coastal places</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duct in RA path</td>
<td>mm</td>
</tr>
<tr>
<td>Ducted return air system</td>
<td>duct: 19 mm</td>
</tr>
<tr>
<td></td>
<td>duct: 13 mm</td>
</tr>
</tbody>
</table>
P. DOCUMENTATION TO MEASUREMENTS
For each drawing, all supply of ductwork must be accompanied by computer-generated detailed Quantity indicating all relevant duct sizes, dimensions and quantities. In addition, summary sheets are also to be provided showing duct areas by gauge and duct size range as applicable.
Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge-wise.
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.

Q. TESTING
After duct installation, a part of duct section (approximately 5% of total ductwork) may be selected at random and tested for leakage. The procedure for leak testing should be followed as per SMACNA- “HVAC Air Duct Leakage Test Manual: (First Edition).

A. DUCTS
SCOPE
The scope of this section comprises the supply and application of insulation conforming to these Specifications.
Insulation material shall be non toxic, chemically inert, non combustible, non ignitable, shall have zero ozone depletion potential, zero calorific value no heat evolution and shall be inherently proof against rotting, mould and fungal growth and attack by vermin.
The materials shall comply with following standards.
• BS 476: Part 4 – Non Combustible
• BS 476: Part 5 – Not easily Ignitable (Class P)
• BS 476: Part 6 – Fire propagation Index (I<12)
• BS 476: Part 7 - Surface spread of flame (Class 1)
• The material should comply to Class'O' fire rating as per BS 476 part 6&7.
• The product shall be able to work effectively at ambient temperature range of -100ºC to 150 ºC

B. AHU / DUCT ACOUSTIC LINING (Insulation Thickness & Density as per requirements)
Insulation material for Duct Acoustic Lining shall be open cell antimicrobial nitrile rubber with self adhesive. The thermal conductivity of the material for air-conditioning application shall not exceed 0.047 W/m.K at 20 deg C. Thickness of the material shall be as specified for individual application as per requirements.
Ducts so identified and marked on drawings and included in BOQ shall be provided with acoustic lining of thermal insulation material for a distance of minimum 5 meters as follows:
The inside surface for the ducts shall be covered with nitrile rubber with self adhesive, and provided with 22 gauge GI Channels 25 x 25 mm screwed back to back and fixed on the inside of duct, spaced not more than 60 cm center to form a frame work of 60 x 60 cms square. Cut panels 60 x 60 cms of resin bonded fiber glass shall be fitted in the squares.

QUALITY CHECKS ON DUCTING
<table>
<thead>
<tr>
<th>No.</th>
<th>DESCRIPTION</th>
<th>YES</th>
<th>OK</th>
<th>NO</th>
<th>MARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Whether material adheres to Fabrication standards as specified (Look form Quality Sheets)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>id for construction Drawings at site.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>ss breaking, bracings / reinforcements are as per standard.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>tightness of transverse / Longitudinal Joints assured.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>ease and heat resistant sealant for kitchen exhaust duct.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>neoprene gaskets for pharmaceutical and clean room projects used</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Check following aspects of duct supporting system</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>ger spacing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>or bolts size and quality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>mber painting of supports</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Check allowable load on trapeze angle for bigger ducts</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Check whether contractor has provided</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>ses in elbows</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>ticked collar at take Offs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>itters</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Check transitions &amp; offsets slopes &amp; fabrication.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>ether the installed ducting is as per layout approved, check locations, headroom etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>ether grilles / diffusers are as per approved shade.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Check the method of installation for Grilles / diffusers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>air / paint damaged surfaces.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Check the coordination of following activities as per the given sequence:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>1 Ducts Cut for taking collars</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>2 Cut / Fabricate collar taking false ceiling framework for diffuser into account</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>3 Grilles / diffuser framework in false ceiling</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>4 all the collar</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>5 all diffuser</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>elbows / turning points and branches to be properly supported</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>ess door is provided at serviceable position for fan and fire damper</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>balancing for room is studied</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>replacement is considered for air exhausted from room.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>or stainless steel material is used for corrosive</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>DESCRIPTION</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>-------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>fume exhaust system.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>anti vermin netting installed for louvers movable and serviceable.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>water or gas vent outlet is not installed near air take louver.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>kitchen exhaust is not short circuited to outdoor intake louver.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>then room pressure is slightly below the surrounding area.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>sound level of fan is studied.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>face velocity for louvers / grills / diffusers is studied.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>distribution of the room is studied.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>cross break all flat surfaces to prevent vibrations or buckling due to air flow.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>all ducts having collar for grills should not be cross broken to facilitate alignment of grills.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>bends and collars should have vanes.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>duct passes through fire chamber increase sheet thickness.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>then exhaust ducts to be tapered at bottom for oil / grease collection.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>avoid flanged joints in kitchen exhaust duct above false ceiling.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>all aluminum ducts are used with steel angles, steel to be painted with Zinc chromate paint.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>provide check nuts with duct hangers.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>all ducts below 250 mm should not be more than 1 m long to facilitate proper joining.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>nims should have flanged and bolted ends for rigidity and easy maintenance.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>avoid 'U' bends in ducts.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>provide long radius bends and offsets.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>collars to be taken from top.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>all duct spool pieces near equipment for easy movable.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.17 COPPER PIPING

- Heavy gauge soft copper tubing, type M, shall be used to make connections to equipment, wherever required or specified by Engineer-in-Charge.
- Flare fittings e.g. flare nuts, tees, elbows, reducers, etc. shall all be of brass.

A. REFRIGERANT PIPING

The refrigerant circuit piping shall be of carbon steel seamless, as per ASTMA-106, grade B or BS-3602 grade 23 and dimensioned as per ANSI B-36.1, schedule 40. The fittings shall be...
heavy class. The pipes and fittings shall be connected by means of welded joints. The connections to gauges, controls, etc. shall be with flare fittings. The refrigerant valves, required in the circuit shall be as follows:

<table>
<thead>
<tr>
<th>Valve Size</th>
<th>Valve Material</th>
<th>Type of Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 12mm</td>
<td>Brass packless type</td>
<td>Flare</td>
</tr>
<tr>
<td>16mm and above</td>
<td>Brass/Steel packed</td>
<td>Brazed/Welded type</td>
</tr>
</tbody>
</table>

**Note:** All valves shall be tested against leaks upto 28 kg/sq.cm.

The strainers for the refrigerant liquid line shall be 'Y' type with gun metal body and bronze filter screen of fine mesh. The filter screen shall be easily removable type without dismantling the strainer from the circuit. The moisture indication sight glass in the liquid line shall have leak proof glass on opposite sides to permit easy inspection of the liquid refrigerant. Silencers and moisture drier etc. shall be provided as part of the refrigerant piping.

Bolts wherever used shall be electro-galvanized steel. Brazed joints, in the refrigerant piping, which has leak, shall be opened and re-done. These shall in, no case be repaired by addition of brazing alloy to the joint.

**B. DRAIN PIPING**
- The drain piping shall be medium class galvanized steel as per IS: 1239 (as per latest amendment).
- The fittings shall be of as per IS: 1239 Part-II with screwed connections.
- The gate valves shall be of gun metal as described earlier.
- Pipe crosses shall be provided at bends, to permit easy cleaning of drain line. The drain line shall be provided upto the nearest drain trap and pitched towards the trap.
- Drain lines shall be provided at all the lowest points in the system, as well as at Equipments where leakage of water is likely to occur, or to remove condensate and water from pump glands. The drain pipe work shall be carried out with threaded joints only. No welded joint shall be permissible.

**C. PAINTING**
- All pipes supports, hangers, etc., shall be given two coats of red oxide primer.
- All pipes (insulated and non insulated) shall then be given two coats finish paint, of a type and color as approved by the Engineer-in-Charge.
- Angle iron Flanges, Stiffeners, hangers and supports shall be painted with 2 coats of anti-rust primer and remaining uncovered duct shall be further painted with 2 coats of synthetic enamel paints of black color.

**D. TESTING AND BALANCING**
After completion of ducting work, system shall be tested for air leakage. Leakage if any shall be plugged and all the adjustments and balancing are completed. The air quantity readings shall be recorded. All dampers shall be set and locked in position after the final adjustments. All readings made shall be submitted to the consultants for approval.
E. DUCTWORK & PIPING INSULATION APPLICATION GUIDELINES

Piping and accessory insulation application shall be as follows:

- Pipes shall be thoroughly cleaned with wire brush and rendered free from all rust and grease.
- For insulation of straight pipe slip on method shall be used. For elbows and bends snap off method will be used.
- First 2 coats of specified Insulation adhesive shall be applied then the Insulation shall be fixed tightly on the surface taking care to seal all joints.
- Adequately sized PVC self-adhesive tape shall be provided to seal all joints afterwards Al cladding shall be done as per requirements.

F. DUCT INSULATION

- Insulation material shall be Closed Cell Elastomeric Nitrile Rubber
- Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.033 W/(m.K) at mean temperature of 0°C
- Insulation material shall have anti-microbial product, which is EPA (Environmental Protection Agency), USA approved, as an integral part of insulation which cannot be washed off or worn off.
- It shall give enhanced level of protection against harmful Microbes such as bacteria, mold, mildew and fungi and shall confirm to following standards: Fungi Resistance – ASTM G21 and Bacterial resistance – ASTM G 22 / ASTM 2180.
- The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class ‘O’ Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990 as well the National Building code (NBC) of India.
- Material shall be FM (Factory Mutual), USA approved.
- Moisture Diffusion Resistance Factor or ‘µ’ value shall be minimum 10,000.
- The insulation thickness shall be 9 mm on all ducts except the toilet and basement exhaust.

G. PIPE WORK INSULATION

- All chilled water and drain pipes Insulation shall be as follows. The material will be TF quality Expanded polystyrene of 20kg/m3 density minimum.
  - Upto 100 mm pipe size - 50 mm
  - Above 100 mm pipe size - 75 mm

1.18 CONTROLS

1. GENERAL

The various controls listed below shall be electrically operated and generally comply with the specifications listed below: In case of low voltage controls necessary step down transformers shall be provided with each control as required.

2. CHILLING UNIT CONTROL
The Chilling machines controls shall be generally standard as per the selected manufacturer standards.

3. **AIR HANDLING UNIT AND FAN COIL UNIT CONTROLS**

- AHUs thermostats shall be cooling/heating suitable for mounting in the room or the return path as required. The thermostat shall be modulating potentiometer type with an adjustable throttling range and required accuracy.
- 2-way motorised Valve for AHUs:
- The motorised water valve shall be globe type and consist of CI/gunmetal valve body with SS trim and equal percentage of flow characteristics, modulating motor and linkage. The valve shall be of 3 way mixing type.
- The thermostat for Fan coil unit shall be space type for cooling. It shall be snap acting type, line voltage, mercury bulb type with differential of 1.1 C. It shall have minimum three speed control complete with wiring etc.
- The water pressure guages shall be of robust construction 150 mm dial of suitable range and occupancy range.
- The thermometers shall be mercurry filled industrial stem type with metal casing and threaded fixing arrangement.

1.19 **NOISE & VIBRATION CONTROL**

A. **SCOPE OF WORK**

This section deals with design, supply, installation, testing and commissioning of noise and vibration control equipment and accessories.

B. **STANDARDS**

The testing of all noise control equipment and the methods used in measuring the noise rating of air conditioning plant and equipment shall be in accordance with the relevant sections of the following British Standards, unless otherwise stated:

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS 4718: 1971</td>
<td>Methods of Test of Silencers for Air Distribution Systems</td>
</tr>
<tr>
<td>BS 2750:</td>
<td>Laboratory and Field Measurement of Airborne Sound</td>
</tr>
<tr>
<td>BS 1-9: 19802750:</td>
<td>Insulation of Various Building Elements</td>
</tr>
<tr>
<td>BS 3638: 1987</td>
<td>Methods of Measurement of Sound Adsorption in a Reverberation Room</td>
</tr>
<tr>
<td>BS 4856: 1976</td>
<td>Academic performance without additional ducting of forced convection equipment.</td>
</tr>
<tr>
<td>BS 5: 1976</td>
<td>Acoustic performance with additional ducting of forced fan convection equipment</td>
</tr>
<tr>
<td>BS 4954: 1976</td>
<td>Acoustic Testing and Rating of Induction Units.</td>
</tr>
</tbody>
</table>
C. GENERAL

The air conditioning contractor must take all necessary precautions to have minimum noise generation and its transmission generated by moving plant and equipment to achieve acceptable limits for occupied areas. In addition to the noise level criteria particular attention must be given to the following details at time of ordering plant and equipment and their installation :-

• All moving plant / equipment shall be statically and dynamically balanced at manufacturers works and certificates issued. The isolation of moving plant, machinery and apparatus including lines equipment from the building structure.

• Where duct work and pipe work services pass through walls, floors and ceilings, or wherever supported shall be surrounded with a resilient acoustic absorbing material to prevent contact with the structure and minimize the outbreak of noise from plant rooms.

• The reduction of noise breakout from plant rooms and the selection of externally mounted equipment and plant to meet ambient noise level requirements of the Specifications.

• Electrical conduits and connections to all moving plant and equipment shall be carried out in flexible conduit and cables to prevent the transmission of vibration to the structure and nullify the provisions of anti-vibration mountings.

• All duct connections to fans shall incorporate flexible connections, except in cases where these are fitted integral within air handling units. All resilient acoustic absorbing materials shall be non flammable, vermin and rot proof and shall not tend to break up or compress sufficiently to transmit vibration or noise from the equipment to the structure.

• Where practicable, attenuators shall be built into walls and floors to prevent the flanking of noise the duct work systems and their penetrations sealed in the manner previously described. Where this is not feasible, the exposed surface of the duct work between the attenuators and the wall subjected to noise infiltration shall be acoustically clad as specified.

D. SOUND ATTENUATORS

Attenuators shall be provided in ducts in accordance with acceptable noise level criteria. Attenuators shall be constructed from high quality pre-galvanised steel sheet casings with lock formed joints along the casing length. Angle iron cross jointing flanges shall be fitted to silencer casings, drilled as required and finished with red oxide primer paint. Acoustic splitters shall be formed by chancel section pre-galvanised sheet steel framework retaining acoustic fill of a density to attain the required performance. Splitters shall have round Nos., ends to give smooth entry and exit conditions to minimise air pressure drops. The acoustic fill shall be protected from the air flow by 22 swg minimum perforated galvanized sheet steel. All attenuators shall be selected against a maximum allowable air pressure drop of 100 Pa. It will be the responsibility of the AC Contractor at the time of placing orders for fan equipment to obtain from the manufacturers, certified sound power levels to enable the selected duct silencers to be checked against the original design information, prior to orders being placed.

E. ANTI-VIBRATION MOUNTINGS
All items of rotating and reciprocating plant and equipment shall be isolated from the structure by the use of anti-vibration materials, mountings or spring loaded supports fixed to either concrete bases, inertia blocks or support steels. Centrifugal fans and motors within air handling units shall be isolated from the frame of the air handling unit by suitable anti-vibration mountings. Fan discharge air connections shall be fitted with approved flexible connections. Axial flow fans shall be mounted on steel legs as diaphragm plates supported on neoprene in shear anti-vibration mountings, or suspended using spring loaded hangers to suite the application. Centrifugal pumps shall be mounted on inertia bases consisting of reinforced concrete sub-base, anti-vibration mountings and concrete filled steel upper plinth. The AC Contractor shall be responsible for providing the steel upper plinth and mountings. Pipe work connections to circulating pumps, chillers, cooler coils and other heat exchanger equipment shall be made with flexible connections as per piping Specifications. The construction of the anti-vibration mountings shall generally comply with the following:

F. OPEN SPRING MOUNTINGS
Each mounting shall consist of one or more helical steel springs as the principal isolation elements, and shall incorporate a built-in leveling device. The spring shall be fixed or otherwise securely located to cast or fabricated telescopic top and bottom housing enclosing one or more helical steel springs as the principle isolation elements, and shall incorporate a build-in leveling device. The springs shall have an outside diameter of not less than 75% of the operating height, and be selected to have at least 50% overload capacity before becoming coil bound. The bottom plate of each mounting shall have bonded to it a neoprene pad designed to attenuate any high frequency energy transmitted by the springs. Mountings incorporating snobbery of restraining devices shall be designed so that the snubbing damping or restraining mechanism, is capable of being adjusted to have no significant effect during the normal running of the isolated machine. The manufacturers shall provide restrained isolator on chillers subject to approval.

G. NEOPRENE-IN-SHEAR MOUNTINGS
Each mounting shall consist of a steel top plate and base plate completely embedded in oil resistant neoprene. Each mounting shall be capable of being fitted with a leveling device, and bolt holes in the base plate and tapped holes in the top plate so that they may be bolted to the floor and equipment where required.

H. INERTIA BASES FOR PUMPS
- The inertia base shall be an all welded mild steel channel frame the minimum depth of which shall be 1/12 of the longest span between isolator but not less than 150 mm. filled with concrete the density of which shall be 2300 kg/m3.
- The inertia base shall be sufficiently large to provide support for all parts of the equipment, including any component, which overhands the equipment base, such as suction, and discharge elbows on centrifugal pumps.
• The frame shall include pre-located equipment anchor bolts fixed into position and housed in a steel sleeve allowing minor bolt location adjustment.
• Isolator support brackets shall be welded into the corners of the base and suitably reinforced for the load of the equipment and base.
• Additional reinforcing roads shall be provided at 200 mm. centres to ensure the concrete and frame is adequately stiffened against distortion.

I. REFERENCE-DESIGN STANDARD

Following standard & guidelines shall be adopted while designing the HVAC System:
• National Building Code of India (NBC 2016) with latest revision.
• Energy Conservation Building Code (ECBC 2007) or latest
• ASHRAE latest Hand Books.
  o Fundamentals
  o HVAC Systems and Equipment
  o HVAC Applications
  o Refrigeration
  o HVAC Design Guidelines for Health Care Facilities.
  o ASHRAE Standard 170.
• Duct construction standards as per relevant latest BIS codes & SMACNA standards.
• Air filters as per ASHRAE 52.1-1992 or latest and 52.2-2007 or latest.
• Indoor Air quality as per ASHRAE 62.1-2010 or latest
• Motors, Cabling, Wiring and accessories as per latest BIS codes.
• National Electric Codes (NEC) latest version
• ANSI / ASHRAE / IESNA standard 90.1-2009 or latest: Energy standard for building except low rise residential buildings.
• ASHRAE standard 55: Thermal Comfort.

J. BIS CODE & GUIDELINES

Followings are the few list of Bureau of Indian Standards Codes for guidelines.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>: 554 - 1985 (affirmed 1996)</td>
<td>Dimensions for pipe threads where pressure tight joints are required on the threads.</td>
</tr>
<tr>
<td>: 694 - 1990 (affirmed 1994)</td>
<td>PVC insulated (HD) electric Cables for working voltage unto and including 1100 volts.</td>
</tr>
<tr>
<td>: 780 - 1984</td>
<td>Sluice valves for water works purposes.</td>
</tr>
<tr>
<td>IS   : 1239 (Part - I) - 1990</td>
<td>Mild steel tube</td>
</tr>
<tr>
<td>IS   : 1239 (Part - II) - 1992</td>
<td>Mild steel Tubulars and other wrought steel pipe fittings.</td>
</tr>
<tr>
<td>: 1255 - 1983</td>
<td>Code of Practice for installation and maintenance of power Cables unto and including 33 KV rating (Second Revision)</td>
</tr>
<tr>
<td>: 1554 - 1988 (Part – I)</td>
<td>Insulated (Heavy Duty) electric cables for working voltages unto and including 1100 volts.</td>
</tr>
<tr>
<td>: 2379 - 1990</td>
<td>Colour code for the identification of Pipelines.</td>
</tr>
<tr>
<td>: 2551 - 1982</td>
<td>Danger notice plate</td>
</tr>
<tr>
<td>: 5312 (Part-I) - 1984</td>
<td>Swing - check type reflux non (Reaffirmed 1990) return valves for water works</td>
</tr>
<tr>
<td>: 5578 &amp; 11353-1985</td>
<td>Marking and identification of conductors</td>
</tr>
<tr>
<td>: 8623 - 1993</td>
<td>Low voltage switchgear and control gear assemblies (Requirement for type / partly type tested assemblies)</td>
</tr>
<tr>
<td>: 8623 - 1993</td>
<td>Bus trunking system (Part - II)</td>
</tr>
<tr>
<td>: 8828 - 1996</td>
<td>Circuit Breakers for over current protection for house hold and similar installation.</td>
</tr>
<tr>
<td>: 9537 – 1981 (Part II)</td>
<td>Steel Conduits for electrical wiring</td>
</tr>
<tr>
<td>: 13947 - 1993 (Part-III)</td>
<td>Switches, disconnectors and fuse for low voltage switch gear and control gear.</td>
</tr>
<tr>
<td>: 13947 - 1993 (Part-IV)</td>
<td>Low voltage switch gear and control gear for contactors and motor starters</td>
</tr>
</tbody>
</table>
1.20 MODE OF MEASUREMENT

A. GENERAL
This specification covers measurement of various items/materials at site.

B. UNIT PRICES IN THE SCHEDULE OF QUANTITIES
The item description in the Schedule of Quantities is in the form of a condensed resume. The unit price shall be held to include everything necessary to complete the work covered by this item in accordance with the specifications and drawings. The sum of all the individual item prices shall represent the total price of the installation ready to be handed over. The unit price of the various items shall include:

- All equipment, machinery, apparatus and materials required as well as the cost of any tests which the consultant may request in addition to the tests generally required to prove quality and performance of equipment.
- All the labour required to supply and install the complete installation in accordance with the specifications.
- Use of any tools, equipment, machinery, lifting tackle, scaffolding ladders etc. required by the contractor to carry out his work.
- All the necessary measures to prevent the transmission of vibration.
- The necessary material to isolate equipment foundations, from the building structure, wherever necessary and suggested by the Engineer.
- Storage and insurance of all equipment apparatus and materials.
- The Contractor's unit price shall include all equipment, apparatus material and labour indicated in the drawings and/or specifications in conjunction with the item in question, as well as all additional equipment, apparatus, material and labour usual and necessary to complete the system even though not specifically shown, described or otherwise referred to.

C. MEASUREMENTS OF SHEET METAL DUCTS, GRILLES/DIFFUSERS, ETC.

1) SHEET METAL DUCTS
- All duct measurements shall be taken as per actual outer duct surface area including bends, tees, reducers, collars and other fittings. Gaskets, nuts, bolts vibration isolation pads, vanes are included in the basic duct items of the B.O.Q.
- The unit of measurements shall be the finished sheet metal surface area in metre squares. No extra shall be allowed for overlaps.
- All the guide vanes, deflectors access panels, splitter dampers within the duct work shall be considered as part of the duct and nothing will be paid extra on this account.
- The unit duct price shall include all the duct hangers, supports and 'Hilti' metallic fasteners as well as any materials and labour required to complete the duct frame.

2) BOX DAMPERS
Box dampers wherever shown or required in ducts shall be measured as per finished inside cross-sections and paid as per the calculated area in sq.m.

3) **GRILLES/DIFFUSERS**
- All measurements of grilles/diffusers shall be the nominal outlet size excluding the outer flanges.
- The square or rectangular grilles/diffusers shall be measured in plain sq.m.
- All round diffusers shall be measured by their diameters in centimetre.
- All linear diffusers shall be measured as per actual length in meters.

4) **MEASUREMENTS OF PIPING, FITTINGS, VALVES, FABRICATED ITEMS**
   a) **PIPE**
   - Pipes Including Water Piping, Oil Piping, L.P. Gas Piping, Air Piping, Vacuum Piping, etc.
   - All pipes shall be measured in linear meter (to the nearest Cm.) along the axis of the pipes and rates shall be inclusive of all fittings e.g. tees, bends, reducer, elbows, hanger support bracket, etc. Deduction shall be made for valves in the line.
   - The rate quoted shall be inclusive of cutting holes, 'Hilti' metallic fasteners and inclusive of all items as specified in specifications and Schedule of Quantities.
   - Rates quoted shall be inclusive of providing and fixing vibration pads and wooden pieces, wherever specified or required by the Engineer-in-Charge.
   - Flexible connections, wherever required or specified shall be measured as part of straight length of same diameter, with no additional allowances being made for providing the same.
   - The length of the pipe for the purpose of payment will be taken through the centre line of the pipe and all fittings (e.g. tees, bends, reducers, elbows, etc.) as through the fittings are also presumed to be pipe lengths. Nothing extra whatsoever will be paid for over and above the fittings.

   b) **VALVES AND FLANGES**
   - All the C.I. and G.M. valves shall be measured according to the nominal size in mm and shall be measured by number. Such valves shall not be counted as part of pipe length hence deduction in pipe length, will be made wherever valves occur.
   - All gate and globe valves shall include two nos. of flanges and two numbers 150 mm long M.S. nipples, with one side threaded matching one of the valves, and other welded to the M.S. slip-on flanges.
   - Rate for all valves shall also include the necessary number of bolts, nuts and washers, 3mm thick insertion gasket of required temperature grade companion flanges and all items specified in the specification.
   - The rates quoted shall be inclusive of making connections to the equipment, tanks, pumps, etc. and the connection made with an installed pipe line shall be included in the rates as per the B.O.Q.

   c) **STRUCTURAL SUPPORTS**
Structural supports including supports fabricated from pipe lengths for pipes shall be measured as part of pipe line and hence no separate payment will be made. Rates shall be inclusive of hoisting, cutting, jointing, welding, cutting of holes and chases in walls, slabs or floors, painting supports and other items as described in specifications, drawings and schedule of quantities or as required at site by Engineer-in-Charge.

d) COPPER CONNECTIONS FOR FAN COIL UNITS
Copper connection assembly for making connections to the fan coil units shall be measured, as part of the fan coil unit price and shall include brass flare nuts, brass tees, brass reducers, fittings, fixing of automatic 3 way valve, making connections and leak testing, complete assembly as per specifications and drawings. Nothing extra shall be payable on account of any variation in the length of copper pipe.

D. PAINTING
Painting of all pipes, supports, valves and fittings shall be included with the cost of these items. Nothing extra shall be paid for this work. Painting of grilles/diffusers, tanks and equipment wherever required shall be in the cost of these items.

E. INSULATION
Measurement of insulation for vessels, piping, equipment and ducts shall be made over the bare uninsulated surface area of the metal.

a) PIPES
The measurements for insulation of piping shall be made in linear meters through all valves, flanges, and fittings. Pipes/bends shall be measured along the centre line radius between tangent points. If the outer radius is R1 and the inner radius is R2, the centre line radius shall be measured as (R1+R2)/2. Measurement of all valves, flanges and fittings shall be taken in running metre of pipe line as if they are also pipe lengths. Nothing extra over the above shall be payable for insulation over valves, flanges and fittings in pipe line/routings. Fittings that connect two or more different sizes of pipe shall be measured as part of the larger size.

b) DUCTS
The measurements for insulation of ducts shall be made in actual square meters of bare uninsulated duct surface. In case of bends the area shall be worked out by taking an average of inner and outer lengths of the bends. Measurements for damper, flanges, fittings shall be for the surface dimension for the connecting duct. Nothing extra over the above shall be payable for insulation over dampers, flanges and fittings in duct routing.

c) VESSELS
The area of standard dished and flat ends of vessels shall be measured as the uninsulated body of the shell. Areas for other shapes shall be the actual calculated area. There shall be no deduction or additions for nozzles, handle ribs, dampers, expansion joints etc. all projections on vessels or tanks shall be measured separately as pipe/duct.

d) ACCESSORIES INSULATION
The unit of measurement for accessories such as expansion tank, pumps, chiller heads etc. shall be of uninsulated area in square meters. In case of curved or irregular surfaces, measurements shall be taken along the curves. The unit insulation price shall include all
necessary adhesives, vapour proofing and finishing materials as well as additional labour and material required for fixing the insulation.

e) **ACOUSTIC DUCT LINING**
In case of acoustic lining of air ducts, measurements of the bare inside duct surface in square metre, shall be final for billing purpose. The insulation/acoustic treatment shall include cost of battens/sections, supports, adhesives, vapour proofing, finished tiles/boards/sheets as well as additional labour and materials required for completing the work.

f) **ROOF AND WALL INSULATION AND ACOUSTIC TREATMENT**
The unit of measurement for all underdeck roof insulation wall insulation, wall/roof acoustic panel shall be the acoustic uninsulated area of walls, roofs, to be treated, in square metres. The insulation/acoustic treatment shall include cost of battens supports, adhesives, vapour proofing, finished boards/sheets as well as additional labour and materials required for completing the work.

g) **ACOUSTIC BAFFLE BOXES (Wherever required)**
The unit of measurement shall be the exposed inside face of the acoustic baffle boxes in square meters. The unit price shall include all hold fasts, nuts, bolts connecting the size of wall opening and making it good as well. Any additional materials and labour to fabricate and fix the boxes.

**F. PAINTING WORK**
This section deals with painting of various equipment / material supplied under this contract. It gives basic guidance for painting as specified below:

**Application:** The original colour of all equipments like water chilling machines, air-handling units etc. which if get damaged during transportation or during installation shall be painted in original shade with the two coat of paint to give a final finish.

All chilled water pipes shall be painted as per standard code of practice and arrows shall be marked to indicate direction of flow of water.

**COLOUR SCHEME FOR THE EQUIPMENTS / MATERIALS**

<table>
<thead>
<tr>
<th>Description</th>
<th>Standard Colour &amp; Reference</th>
<th>Lettering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed Duct Work (other than plant room)</td>
<td>AS per E-I-C Directions</td>
<td></td>
</tr>
<tr>
<td>Conditioning Duct Work (Plant Rooms)</td>
<td>BSS 111 Pale Blue</td>
<td>ck</td>
</tr>
<tr>
<td>Ventilation Duct Work (Plant Rooms)</td>
<td>BSS 111 Pale Blue</td>
<td>ck</td>
</tr>
<tr>
<td>Air Conditioning Casings</td>
<td>BSS 111 Pale Blue</td>
<td>ck</td>
</tr>
<tr>
<td>Electrical (Conduit Ducts &amp; Motors )</td>
<td>BSS 557 Light Orange</td>
<td>ck</td>
</tr>
<tr>
<td>Chilled Water Pipe</td>
<td>Jade Green</td>
<td>ck</td>
</tr>
</tbody>
</table>
**1.21 SPECIFICATIONS FOR ELECTRICAL WORKS**

**A. GENERAL**

All Electrical works including but not limited to motors, switchgears, power & control/signal cables, earthing, terminations etc. required for various items shall generally be as per specifications given in electrical specifications. Main HVAC Panel shall conform to IS/IEC – 61439 Code latest as amended.

All electric motors shall be suitable for 3 phase, 50 cycles 415 volts a.c. supply.

**B. CONTROL PANEL**

- These panels should be floor/wall mounted, sheet steel clad, modular construction, cubicle design, compartmentalised. These panels shall comprise of incoming & outgoing feeders (circuit breakers, fuse switch units/switch fuse units, contactor starters with overload relays, single phasing preventor etc.

- The panels shall be provided wherever necessary with necessary interlocks designed to prevent incorrect operation and to ensure safety of operating personnel and equipment.

- All feeders are to be operated from the front and they shall be interlocked suitably. Padlocking arrangement and interlock defeating device shall also be provided. Each module shall have separate door and partition plate. The feeder incomer switches shall be interlocking with the door so that the door can only be opened when switch is in ‘off’ position. The doors and covers shall be provided with thick gaskets to make it dust tight. All the door covers shall be provided with synthetic rubber gaskets to make it dust tight. Feeder name tags shall be provided.

**C. CONTACTOR STARTERS**

1) **STAR DELTA STARTER**

The star delta starter shall be air break automatic contactor starter provided with main contactor, star contactor, delta contactor, timer and automatic change over from start to delta, bimetallic over load relay, operating coil, start/stop push button, single phasing preventor, auxiliary make and break contacts, indicating lamps etc. The contactor shall quick

---

<table>
<thead>
<tr>
<th>Description</th>
<th>Standard Colour &amp; Reference</th>
<th>Lettering Colouring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drains</td>
<td><strong>ck</strong></td>
<td><strong>ite</strong></td>
</tr>
<tr>
<td>Valves</td>
<td><strong>ite</strong></td>
<td><strong>ck</strong></td>
</tr>
<tr>
<td>111 Pale Blue</td>
<td>210-25 mm wide</td>
<td></td>
</tr>
<tr>
<td>Vents and Pipe Line Fittings</td>
<td><strong>ite</strong></td>
<td><strong>ck</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Valves and Pipe Line Fittings</td>
<td><strong>ck and yellow diagonal stripes</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
<tr>
<td>Fans</td>
<td><strong>BSS 111 Pale Blue</strong></td>
<td><strong>Black</strong></td>
</tr>
</tbody>
</table>
make, quick break, double break consisting of robust silver contacts. The coil voltage shall be 415 volts ac at 50 hz. The starter shall be provided with trip indication light and overload reset push button for overload relay.

2) DOL Contactor Starter
The contactor shall be air break type coil operate, dol contractor starter, provides with cables entries, ambient temperature compensated bimetallic over load relay, single phasing preventor, solenoid coil, start and stop push buttons, 8 auxiliary make and break contacts, indicating lamps etc. The contactors shall be quick make quick make and quick break, double break type consisting of robust silver contacts. The coil voltage shall be 440 volts at 50 c/s. The starter shall be provide with trip indication light and over load reset bush button for overload relay.

D. SQUIRREL CAGE INDUCTION MOTORS
The motor shall be of well tried out and design and of reputed make. The motors provided on the equipment shall conform to IS: 325 in general. The motors shall be squirrel cage indication motors rates for operation at 415 volts, 3 phase, 50 Hz a.c. supply. The motor for various equipments shall have the following enclosure level.

- Cooling tower & exhaust blower - IP: 55(TEFC)
- Pumps IP: 55(TEFC/SPDP).

The horse power and speed of the motor shall match that of driven equipment and the motor shall be suitable for star delta starting or direct on line starting with class '3' insulation. The motors of 10 HP and above shall be suitable for star delta starting and below 10 H.P suitable for DOL starting. The compressor motor shall be provided with automatic star delta starter.

The console shall contain on/off push bottons and indication lamps for all the items as required. Indicating light for strip heaters, if any shall be provided on the switch board, in the respective unit room.

The requirements given for the main panel are for one unit only. The actual number of switches and lights shall correspond to the number of units being installed. All controls and alarms shall be suitable for 230 volts on the panel. The alarms shall be with reset buttons.

All controls circuits shall be functionally tested. The red indicating lamps should switch on only in case of fault. Thus, the red light should come on in case of tripping of starter on overload or single phasing.

A common alarm shall be connected to all red indicating lamps through individual relays. Lamp testing arrangements shall be provided in console.

All the airconditioning equipments shall be interlocked in sequence for safe and trouble free operations of the plant. Following should be the sequence of operation:

- Airhandling units
- Chilled / condenser water pumps
- Water chilling units.

During switch off operations the sequence shall be reverse.

- For winter heating the following should be the sequence of operations .
- Airhandling unit
- Hot water pumps.
- Hot Water Generator/Boiler
During switch of operations the sequence shall be reverse.

**LIST OF BUREAU OF INDIAN STANDARD CODES**

- IS:277-1992 - Galvanized steel Sheet (plain & corrugated)
- IS:544-1985 - Dimension for pipe Threads
- (Reaffirmed 1996)
- IS:778 - Valves (gate/globe/check type)
- IS:655-1963 - Metal Air Ducts
- IS:13095-1991 - Butterfly Valves
- IS:659-1964 - Air-conditioning (safety codes)
- IS:1239-1990/92 - Mild Steel Pipes
- IS:325 - 3 phase induction motor
- IS:822 - Code of procedure for inspection of welds
- IS:900 - Code of practice for installation and maintenance of motors
- IS:6392 - Steel Pipe Flanges
- IS:1822 - Motor starters for voltage not exceeding 650 Volts
- IEC - Relevant Sections
- IS:996 - Single phase small A.C. Motors
- IEC 61439 - LT Switchgers & Panels
- IS:4894-1987 - Centrifugal Fans
- IS:1554(I) - PVC Insulated (heavy duty)electric cables for working
- IS:8623-1993 - Bus Bar Trunking System
- IS:8828-1996 - Miniature Circuit Breakers
- & IEC898-1995
- IS:9537-1981 Part II - Rigid steel conduit for electrical wiring
- IS:10810-1989 - Method of Test of Cables
- IS:13947-1989 - Circuit Breakers
- IS:13947-1993 - Switches,disconnectors,fuse combination units
- IS:139-1993(Part IV) - Contactors & Motor Starters
- Duct Fabrication standards -SMACNA
- ASHRAE Handbooks -Application 1995
- Fundamentals 1997
- System & equipment 1996
- Indoor Air Quality 62-1982
CHAPTER- 14
TECHNICAL SPECIFICATIONS- FIRE FIGHTING SYSTEM

1. FIRE FIGHTING WORKS- FIRE PROTECTIONS
Scope of work shall include design, engineering, supply, installation, testing & commissioning of firefighting system.
All material shall be of conforming to relevant IS specifications wherever exists and subject to approval of Engineer in charge.
The firefighting shall be carried out strictly as per NBC -2016.
Testing, commissioning & getting approvals from various inspection authorities and obtaining No objection certificate (NOC) for occupation of Lab buildings.

1.1. TENDER DRAWINGS
For guidance of the bidder, drawings (Internal Fire Fighting Layout/External Fire Layout, etc.) are enclosed with these tender documents. These drawings are broadly indicative of the work to be carried out. The contractor on award of work will furnish detailed stage-wise working drawings as required in advance for approval of Engineer and get the same approved by Local Fire Authority/other statutory bodies. No claim whatsoever shall be admissible on account of changes that may be introduced by the Engineer/ Local Fire Authority.

1.2. SHOP DRAWINGS/TECHNICAL DATA SHEETS
The contractor shall prepare and furnish all shop drawings including floor plans & Terrace, Schematic Fire Fighting Layout/External Fire Layout showing sprinklers, Fire Hydrants/First Aid Hose, Zonal Control Valves, Extinguishers, Signage's, Terrace layout with OHT.
Such shop drawings shall be based on the Architectural drawings/Tender Drawings and requirements laid down in the Specifications, BOQ and as per site conditions. The manufacturing of equipment shall be commenced only after the shop drawings/GA Drawings/ technical data sheet along with pump curves are approved in writing by the Engineer. Such drawings shall be coordinated with other services work. These shop drawings will be approved by HITES which will be considered as base for execution of fire fighting work.

1.3. COMPLETION / AS BUILT DRAWINGS
On completion of the work and before issuance of certificate of virtual completion, the contractor shall submit to the Engineer –in-Charge, General Layout drawings, drawn at approved scale indicating layout of all Firefighting items, piping and its accessories “As installed”. As built drawings shall be prepared taking approved shop drawings as base & incorporating all changes/ modifications as per site conditions. These drawings shall include the following:·
- Fire fighting floor layout including terrace indicating internal hydrants, sprinklers complete with pipe dia., pipe spacing interval etc.
- Complete schematic as installed.
1.4. **DRAWINGS & DOCUMENTS**
The contractor shall submit to the Engineer, the following documents on completion of the work and before issuance of virtual completion.

- Warranty for required equipment installed
- As Built Drawings
- Material Test Certificates
- Catalogues/Brochures
- Operation and Maintenance Manuals
- List of recommended spares and consumables
- All approvals including technical approvals and sanctions
- NOC from Fire authority before commencement of execution & after completion of entire work etc.

1.5. **SANCTION/ APPROVALS FROM STATUTORY AUTHORITIES/ LOCAL FIRE AUTHORITY**
The contractor shall be fully responsible and shall carry out following activities:-

- Preparation & submission of working drawings
- Obtaining the approval of drawings
- Arranging inspection of site by officials of the Authority
- Obtaining the final No objection/ completion certificate after submitting required documents.
- Any other statutory approvals required.

1.6. **MANUFACTURING**
The responsibility for ensuring the manufacture of the equipment as per the specifications shall be solely that of the contractor. The contractor shall be responsible for selection of materials as per agreed specifications and BOQ.

1.7. **MAKE OF MATERIALS/MANUFACTURER’S INSTRUCTION**
Only approved makes as mentioned in our approved make list of tender documents of material shall be used. The Contractor shall furnish Technical data sheets / GA drawings of all items before placing P.O. The contractor shall get the samples of required items approved from the HITES as conveyed by E-I-C before commencing the supply. In case of any discrepancy/anomalies wrt specifications, prior intimation from Contractor to E-I-C to be given. Final decision lies with HITES for according approvals.

Any specific instruction furnished by manufacturer covering the points not mentioned in technical specifications of the tender shall be brought to the notice of E-I-C in writing for further instructions in this regard at appropriate time.

**MATERIAL TESTING**
The E-I-C shall have full power to get any material of work to be tested by an independent agency at contractor’s expense in order to prove the soundness and adequacy.
1.8. **INSPECTION AND TESTING**

- All equipment shall be inspected and tested as per an agreed Quality Assurance Plan before the same is packed and dispatched from the contractor's works. The contractor shall carry out tests as specified/directed by engineer.
- Contractor shall perform all such tests as may be necessary to meet requirements of Local Authorities, Municipal or other statutory laws/bye-laws in force. Nothing extra shall be paid for these.
- The E-I-C may, at his sole discretion, carry out inspection at different stages during manufacturing and final testing after manufacturing.
- Approvals or passing of any inspection by the engineer or his authorized representative shall not, however, prejudice the right of the engineer to reject the plan if it does not comply with the specification when erected or give complete satisfaction in service.

1.9. **TRAINING OF DEPARTMENT PERSONNEL**

- The contractor shall train the CLIENT/ HITES’s personnel to become proficient in operating the equipment installed. Training shall be done before the expiry of the defects liability period (one year after completion & handing over).
- The period of training shall be adequate and mutually agreed upon by the Engineer and contractor.
- The CLIENT/ HITES’s personnel shall also be trained for routine maintenance work and lubrication, overhauling, adjustments, testing, minor repairs and replacement.
- Nothing extra shall be paid to the contractor for training CLIENT/ HITES’s personnel.

1.10. **PERFORMANCE GUARANTEE**

At the close of the work and before issue of final certificate of virtual completion by the engineer, the contractor shall furnish written guarantee indemnifying the CLIENT/ HITES against defective materials and workmanship for a period of one year after completion and handing over. The contractor shall hold himself fully responsible for reinstallation or replace free of cost to the CLIENT/ HITES.

- Any defective material or equipment supplied by the contractor.
- Any material or equipment supplied by the CLIENT/ HITES which is proved to be damaged or destroyed as a result of defective workmanship by the contractor.

2. **PIPING FOR WET RISER SYSTEM**

2.1. **SCOPE**

This section covers the details of requirement of piping used in wet riser system, including the associated auxiliary equipment.

2.2. **GENERAL**

The wet riser system shall remain pressurized at all times during operation, and as such the piping work shall be carried out to withstand the same.

2.3. **PIPES AND 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.
Screwed fittings shall be approved type malleable or cast iron with reinforced ring on all edges of the fittings suitable for screwed joints. Forged steel fittings of approved type with "V" groove for welded joints. Fabricated fittings shall be not being permitted for pipe diameters 50 mm and below. When used, they shall be fabricated, welded and inspected in workshops whose welding procedures have been approved by the TAC as per TAC rule 4102 for sprinkler system and applicable to hydrant and sprinkler System under the supervision of Engineer-In-Charge. For "T" connections, pipes shall be drilled and reamed. Cutting by gas or electrical welding will not be accepted. Pipes for Wet Riser system shall be of black steel MS conforming to IS: 1239/3589 (Heavy Class/ Class C). Fittings for black steel pipes shall be malleable iron suitable for welding or tapered screwed threads.

2.4. JOINTING

2.4.1. Screwed (50 mm dia pipes and below)
Joint for black steel pipes and fittings shall be metal to metal thread joints. A small amount of red lead may be used for lubrication and rust prevention. Joints shall not be welded or caulked.

2.4.2. Welded (65 mm dia and above)
Joints between M.S. pipes and fittings shall be made with the pipes and fittings having "V" groove and welded with electrical resistance welding in an approved manner. Butt welded joints are not acceptable.

2.4.3. Flanged
Flanged joints shall be provided on:
- Straight runs not exceeding 30 m on pipe lines 80 mm dia and above.
- Both ends of any fabricated fittings e.g. bend 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 per good engineering practice.
- Flanges shall be as per Table 17 of IS-6392 with appropriate number of G.I. nuts and bolts, 3 mm insertion neoprene gasket complete.

2.4.4. Unions
Approved type of dismountable unions on pipes lines 65 mm and below in similar places as specified for flanges. Joint for black steel pipes and fittings shall be metal to screw grid up to 50 mm dia and above 65 mm dia welded joints. A small amount of red lead may be used for lubrication and rust prevention in threaded joints. Hold tight will be use for threaded pipes joint.

All the welding shall be radiographically tested. Joints between MS pipes, valves and other appurtenances, pumps etc. shall be made with M.S. flanges with appropriate number of bolts. Flanged joints shall be made with 3mm thick insertion rubber gasket.

2.5. DIA OF FLANGE AND HOLE CONFORMING IS:

<table>
<thead>
<tr>
<th>Size of pipe</th>
<th>80 mm</th>
<th>100 mm</th>
<th>150 mm</th>
<th>200 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dia of flange</td>
<td>200 mm</td>
<td>220 mm</td>
<td>285 mm</td>
<td>340 mm</td>
</tr>
<tr>
<td>Flange thickness</td>
<td>20 mm</td>
<td>20 mm</td>
<td>22 mm</td>
<td>24 mm</td>
</tr>
<tr>
<td>Dia of bolt</td>
<td>16 mm</td>
<td>16 mm</td>
<td>16 mm</td>
<td>16 mm</td>
</tr>
</tbody>
</table>
2.6. 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.
- Pipes in chase or buried underground shall be painted with two coats of hot bitumen, wrapped with bituminous pypkote or Hessian cloth and finished with one coat of hot bitumen paint.
- Pipe passing through structural members will be provided with M.S. pipes.

2.7. PIPE SUPPORTS

All pipe clamps and supports shall be galvanized mild steel. When fabricated from M.S. steel sections, the supports shall be factory galvanized before use at site. Welding of galvanized clamps and supports will not be permitted.

Pipes shall be hung by means of expandable anchor fastener of approved make and design (Dash Fastners or equivalent). The hangers and clamps shall be fastened by means of galvanized nuts and bolts. The size/diameter of the anchor fastner and the clamp shall be suitable to carry the weight of water filled pipe and dead load normally encounted. For pipe spacing, the stringent of the IS Code clause no. 10.3.10, table -11 & below mentioned table should be opted.

2.8. ORIFICE PLATES

Contractor shall provide orifice flanges fabricated from 6 mm thick SS plates on the branch lines feeding different zones/floors (as required) so as to allow required flow of water at 3.5 Kg/ sq.cm. Pressure. The contractor shall furnish design for these orifice flanges. The orifice shall be plain central hole without burs, diameter not less than half of the internal diameter of pipe to which it is fitted.

2.9. AIR CUSHION TANK AND AIR RELEASE VALVE

Air vessel on top of each wet riser/ sprinkler piping shall be installed before execution for approval fabricated out of at least 8 mm thick steel to withstand the pressure, with dished ends and supporting legs. This shall be of 250 mm dia and 200mm high. This shall be completed with necessary flange connection to the wet riser/ sprinkler piping and air release valve with necessary piping to meet the functional requirement of the system. The air vessel shall be of continuous welded construction and painted with Red Color. This shall be tested for twice the working pressure. The drain arrangement will have 25mm dia GM valve with required accessories and pressure gauge. ARV shall be of 25 mm of forged brass body & chrome plated & its components shall be of anticorrosive material. Test Pressure (Hydrostatic) for Shell: 15 bar (220 psig), Seat: 10 bar (150 psig) & Maximum Working Temperature: 110 degree C.

2.10. VALVES, GAUGES

**Butter-fly, Sluice valves and NRV** above 65 mm shall be of cast iron body. They shall conform to type PN 16 of IS: 13095,780. Valve wheels shall be of right hand type and have an arrowhead engraved or cast thereon the direction for turning open and closing.

**Butterfly valves** of various dia. as per requirements shall be of wafer type, conforming to PN-16 rating with SS disc. It shall be lever operated. The rubber lining shall be integrally moulded with EPDM/Nitrile rubber. The O-ring shall be made of nitrile rubber. The lever shall be made preferably of carbon steel.

The test pressure of Shell- 24 Bar, Seat:17.6 bar & maximum working pressure-16 bar, maximum working temperature :90 degree celcius. In case of any discrepancies between
manufacturer’s standards & above specified values, these parameters shall be in compliance with relevant IS codes.

**Non-return valves/ Dual plate check valve** of various dia. as per requirements shall be of cast iron body. It should have Nitrile Rubber/EPDM Seal & Disc of stainless steel. They shall be swing check type/wafer type in horizontal runs and lift check type in vertical runs of piping. It should be of min. PN-16 rating. Test Pressure (Hydrostatic) : Shell: 24.50 kg, Seat:16 kg/Sq.cm, maximum operating temperature- 80 degree C. In case of any discrepancies between manufacturer’s standards & above specified values, these parameters shall be in compliance with relevant IS codes.

**Sluice valve** shall be of CI construction. The seat shall be of bronze. Hand Wheel shall be of cast iron. It should be of min. PN-16 rating.

**The Ball valve** of various dia. Shall be of forged brass construction & shall have screwed female ends. It shall be lever operated with quarter turn & shall be provided with forged brass hard chrome plated ball. It shall be complete with premium quality PTFE gland packing & seating. The ball valve shall be with chrome finish wherever required. Test Pressure (Hydrostatic): Shell: 25 kg, Seat: 16 kg/Sq.cm, maximum operating temperature- 220 degree C. In case of any discrepancies between manufacturer’s standards & above specified values, these parameters shall be in compliance with relevant IS codes.

**Pressure gauge (Bourdon Type)** shall be of suitable range with SS 304/316 Construction, case of 150/100mm diameter. The gauges shall have brass cocks. The accuracy range of pressure gauge shall be in the range of + - 0.5 % to 1%. It shall conform to IP 67 protection. The dial shall be Aluminium white background with black letters. The windows shall be made of plain & toughend glass. The suitability of pressure gauge shall be in the temperature range of (-) 20 degree Celcius to 60 degree celcius. The gear mechanism shall be of SS 304 & the connection material shall be of SS-316 L. Pointer shall be of black aluminium. It shall be complete with all accessories such as siphon, gauge cock, snubber & needle valve etc. Pressure range shall be between 0 to 20 kg/Sq.cm.

**Double flanged MS pot strainers** of required dia. With M.S. body and SS 40-grade mesh strainer, PN 16 shall be provided either at tank suction line or at individual pump suction line.

**Orifice plates** shall be made of 6mm thickness Brass material to reduce pressure on individual hydrants to operating pressure of 3.5-kg/ sq.cm. Design of the same shall be given by the contractor as per location and pressure condition of each hydrant.

### 2.11. EXTERNAL YARD HYDRANTS

External yard hydrants shall be of ‘Stand Post’ type conforming to IS: 908 and comprise stand post for single or double outlet, duck foot bend, flange riser and single headed brass/ gunmetal valve conforming type A / type-B and conforming to IS: 5290.

The stand post column shall be of cast iron, cast in one piece, conforming to grade 20 of IS: 210 or M.S. pipe. The internal diameter at the top shall be at least 80 mm.

The outlet shall be angled towards ground, with instantaneous spring lock type gunmetal female coupling of 63 mm dia. For connecting to hose pipe. It shall be with ISI marked with Sl. No. clearly mentioned. The landing valve shall be of oblique pattern shall be complete with GI twist release chain with cap. The manufacturer’s name & trademark along with year of manufacture & other details like size & type shall, be clearly mentioned. Valves shall be provided with one coat of primer & subsequently painted with 2 coats of red paint with shade no. 536 conforming to IS 5. The paint shall conform to IS 2932. Hand Wheel shall be painted black. It shall be BIS approved. Blank caps shall be made of gun metal. Hydrostatic pressure test shall be carried out at 21 kg/Sq.cm for 2.5 mins.
The flow test shall be at 7 kg/Sq.cm at 900 lpm. The water tightness seat test shall be at 14 kg/Sq.cm. In case of any discrepancies between manufacturer’s standards & above specified values, these parameters shall be in compliance with relevant IS codes. RRL Hose pipe shall be controlled percolating (CP) type, ISI marked (IS:8423), 63 mm dia x 15 m long (2 Nos.) complete with instantaneous type gunmetal 63 mm dia ISI marked Male & Female couplings (IS:903) bound and riveted to hose pipe with copper rivets and 1.5 mm copper wire.

Bursting pressure not less than 22 Kg/Sq.cm. External Hydrant post shall also include standard short size 63mm dia. Gunmetal branch pipe with gun metal nozzle of 20 mm nominal bore outlet with instantaneous type 63 mm dia coupling complete & confirming to IS:903. M.S. fire hose weather proof cabinet (750x600x250mm 385namele) made out of 16 gauge M.S. sheet capable of accommodating landing valve, hose pipes, fittings & accessories. The box shall have a front glass door with lock and key arrangement & shall be painted with one coat of primer & two coat of finished stove 385nameled post office red colour paint & “FIRE HOSE” written on front.

2.12. INTERNAL HYDRANTS

The landing valve shall be of oblique pattern shall be complete with GI twist release chain with cap. The manufacturer’s name & trademark along with year of manufacture & other details like size & type shall, be clearly mentioned. Valves shall be provided with one coat of primer & subsequently painted with 2 coats of red paint with shade no. 536 conforming to IS 5. The paint shall conform to IS 2932. Hand Wheel shall be painted black. It shall be BIS approved. Blank caps shall be made of gun metal. Hydrostatic pressure test shall be carried out at 21 kg/Sq.cm for 2.5 mins. The flow test shall be at 7 kg/Sq.cm at 900 lpm. The water tightness seat test shall be at 14 kg/Sq.cm. In case of any discrepancies between manufacturer’s standards & above specified values, these parameters shall be in compliance with relevant IS codes. RRL Hose pipe shall be non-percolating type, ISI marked (IS:8423), 63 mm dia x 15 m long (2 Nos.) complete with instantaneous type gunmetal 63 mm dia ISI marked Male & Female couplings (IS:903) bound and riveted to hose pipe with copper rivets and 1.5 mm copper wire. Bursting pressure not less than 22 Kg/Sq.cm. External Hydrant post shall also include standard short size 63mm dia. Gunmetal branch pipe with gun metal nozzle of 20 mm nominal bore outlet with instantaneous type 63 mm dia coupling complete & confirming to IS:903. Internal hydrant shall be with firemans axe with heavy rubber handle. Swing type First Aid hose reel in red color with 36 meters long and 20 mm dia heavy duty rubber water hose, 20 mm dia globe valve stop cock, terminating with G.M. coupling & nozzle of 5mm outlet with shut off valve confirming to IS 8090 – 1976 complete with drum and brackets for fixing on wall, bolts & nuts conforming to IS:884-1969 complete as required to be provided. MS door made up of 16 gauge MS Sheet capable of accommodating fire hose reel, landing valve, hose pipes, fittings, 1 No. CO2 & 1 No. Dry powder type portable fire extinguishers & accessories. The door shall have a front glass with lock and key arrangement & shall be painted with one coat of primer & two coat of finished stove enameled post office red color paint & “FIRE HOSE” written on front.

(Approx. size of door: 2100 mm Height, Width of Door as per Shaft size)

2.13. FIRE BRIGADE INLET CONNECTIONS/ DRAW OFF CONNECTION
One set of 2/4 ways collector head Fire Brigade connection shall be provided at underground tank, Ring Main, Sprinkler system and individual wet risers as specified conforming to IS 904.

The inlet to the wet riser sprinkler header shall be with 150 mm dia butterfly or sluice valve and non-return valve. The scope shall include necessary reducers, tees bends and special fittings as required.

It should be provided with M.S. enclosure fabricated from 1.5 mm thick M.S. sheet, front glass locking arrangement supported on M.S. structural members, painting with two coats of postal red enamel.

Fire brigade inlet connection (fire department connection) consisting of 4 Nos. 63 mm dia instantaneous inlet arranged on a 50 mm dia header, 1 No. 150 mm diameter sluice valve, with in built Non-return valve and wall mounted box of M.S. construction made out of 16 gauge MS Sheet with glass door to house the above mentioned components.

Fire brigade draw out connection (fire department connection) with suction pipe MS class ‘C’ 100 mm dia. & 100 mm dia. Foot valve & steel chain including wall mounted box M.S. construction made out of 16 gauge MS Sheet with glass door to house the above mentioned components.

Inlet breeching having C.I. body Two way gun metal 63 mm dia instantaneous inlets conforming to IS 903 fitted with Non-return valves, 25 mm dia gun metal drain cock, blank cap, brass chains and 150 mm dia flanges with all accessories suitable for local fire tender complete as required.

3. PORTABLE FIRE EXTINGUISHERS:

3.1. Portable Fire Extinguishers:

**ABC Powder stored pressure type** Fire Extinguishers of 6 Kg capacity conforming to IS : 15683 & CO₂ gas based Fire Extinguisher of 4.5 Kg capacity conforming to IS : 15683 is proposed for all floors near internal hydrant locations.

**4.5 kg carbon dioxide extinguisher**, IS marked shall be complete with high pressure discharge tube, horn, control valve & CCE approved cylinder. It shall be suitable for extinguishing Class B & C fires. It shall be provided with Wheel type /Squeeze grip type with discharge hose & horn. It shall be suitable for operation within the temperature range of (-) 20 degree Celsius to 55 degree Celsius. The test pressure shall be 250 Bar. The minimum effective discharge shall be 95 percent.

6 kg & 9 kg Mono **Ammonium Phosphate (ABC) type cartridge** operated extinguishers. The minimum effective discharge shall be 85% & the minimum jet length shall be between 2-3 meters. The discharge pressure time shall be between 8-13 seconds. The hydraulic test pressure shall be 35 kg/Sq.cm & the charge test pressure shall be 15 kg/Sq.cm & the operating range shall be within (-)5 to 55 degree C. The operating valve shall be squeeze grip type with discharge hose & nozzle.

**Higher capacity Trolley mounted Dry Chemical; Powder type** Fire Extinguisher of capacity 25 kg. confirms to IS 10658, bearing ISI mark, ( Outside Cartridge ). CO₂ type Fire Extinguisher of capacity 22.5 kg filled with Co2 Gas as per IS 15222 with control discharge mechanism fitted with Hose, Horn & Trolley confirms to IS 2878 bearing ISI mark. Co2 Cylinder as per IS 7285. The hydraulic test pressure shall be 250 Bar. The
Operating range shall be between (-) 30 to 55 degree C. It shall be suitable for extinguishing fires of class B & C.

50 Lit. trolley mounted cartridge type fire extinguisher (Foam) :- It shall be suitable for extinguishing fire of class A & B. The minimum effective discharge shall be 90% & minimum jet length shall be 10 meters. The discharge pressure time shall be between 60-180 seconds. The hydraulic test pressure shall be 30 kg/Sq.cm & type of extinguisher media shall be water & AFFF (3 lit. of 6% concentrate).

The ISI marked Extinguisher and their installations shall be in accordance with acceptable standard of NBC 2016. These units shall be mounted at a convenient height to enable to its quick Access. The requirement shall be as per NBC 2016 Part – 4 Table -7.

3.2. CLEAN AGENT FIRE EXTINGUISHERS

Clean Agent Fire Extinguishers are proposed to be provided for extinguishing fire of sensitive equipment, the HFC 236fa or equivalent Clean Agent Extinguisher shall be the most eco-friendly extinguisher. FE36 Clean Agent Extinguishers shall leave no residue, pack in mega power and shall be absolutely safe for use on any sensitive electronic equipment.

- They should have zero ODP (Ozone Depletion Potential). They shall be extremely lightweight, yet packed with tremendous power and shall throw, to penetrate past even the finest grills and meshes.
- It shall be Residue free: It shall leave no residue making it safe for use on sensitive equipment.
- Valve Construction : Forging & Machining
- Internal Coating of Can : Epoxy Powder coating
- External Coating of Can : Epoxy Polyester Powder coating
- Tests: Helium Leak Detection
- Sheet metal thickness: 1.60 mm (approx.),
- It shall be Lightweight: Extremely lightweight, yet packed with tremendous power and throw, to penetrate past even the finest grills and meshes.
- It shall be Easy snap safety seal: A completely tamper proof safety seal that can be broken in seconds.
- It shall be complete with pressure gauge, discharge mechanism with Easy Snap Lever Lock, EPDM rubber hose & shall Fight Class A , B and electrically started Fire, extinguisher has ISO 9001 and CE certifications, preferably UL listed & FM approved, and conforms to ISI standards & shall have preferably 5 years of warranty.
- It shall be preferably 6 kg capacity with Discharge time: 8 Secs (approx.) & Range: 2 Meters (approx.)

4. FIRE SIGNAGES :-

Various types of signage are proposed in the complex as per NBC 2016 Part -4. At every floor near Lift landing diagram showing stairways shall be provided mentioning instructions - 'IN CASE OF FIRE USE STAIRS UNLESS INSTRUCTED OTHERWISE'. The
signage shall be above call button in Lift Lobby. Floor Signage indicating Exit path will be provided in each floor within the staircase. The Numerical shall be Bold Type of minimum 75 MM height. Each corridor of every floor will have directional signage indicating Fire Escape route. These Signage may be LED lit with UPS power backup or of photo luminescent paint. So that they will be visible in dark in case of power failure. Fire related signages shall be printed on photo luminescent U1000 aluminum sheet of 1.0 mm (+-10%)/Acrylic Board containing Lumigen II as base chemical, covered under UV stabilized coating and of appropriate size including fixing on wall, door, ceiling etc. with proper clamps, hangers, cleats, anchor fasteners etc. complete in all respects. Text shall be double sided or single sided as per requirements.

5. INSTALLATION, TESTING AND COMMISSIONING

5.1. SCOPE

This section covers the requirements of installation of the various components of the wet riser system.

A survey of the site of the work shall be made by the contractor before preparation of the detailed drawings for submission to the department for approval. The installation shall be carried out strictly in accordance with the approved drawing.

The scope of installation work shall include the following, where or not expressly mentioned in the schedule or work:

- Filling up the hole in flooring with cement concrete, after laying the wet riser pipes
- Necessary supports and camps for wet riser plumbing in the building
- Excavation of the earth, consolidation and refilling after laying of wet riser piping in ground.
- Provision of necessary brick base or intermediate support as required in approved manner in case of soils which are not strong enough to support the pipes, thereby likely to case different settlement.
- Necessary anchor block of ample dimensions in 1:2:4 cement concrete at all bends, tee connections, foot of the wet riser, and other places as required to stand the pressure thrust in pipes.
- Necessary masonry work/ steel work for supporting hose cabinets near external (yard) hydrants.
- Valve chambers of approved design with external (yard) hydrant.
- Ground level hydrants of approved design, where specifies.
- Cutting and making good the damages for the installation work of the riser system
- Orifice plates at individual hydrants as required.

Where provision of MS pipe shall below ground become inescapable, it shall be protected from soil corrosion by two coats of bitumen painting and wrapped with bituminous Hessian cloth and finish with hot bitumen paint.

Each MS pipe shall be subjected to hydraulic pressure test before installation, in presence of the Engineer or his authorized representative.

External (yard) hydrants shall be located at least 2m away from the face of the buildings but not more than 15m and be accessible. Distance between the two hydrants should not be more than 45 metre.
Where external hydrants are below ground level, they shall be enclosed in masonry trenches of size 75Sq.cm and 8cm above ground level. The hydrant shall be within 8cm from the top of the enclosure. Landing Valve of Internal hydrant at each floor shall be located at about 1m above floor level. Valve chambers in ground shall be of 1sqm in size, with cover.

5.2. PAINTING
Painting of the entire wet riser piping over the ground shall be done with anticorrosive primer and 2 coats of approved paint. The color shall be red to shade No. 536 of IS: 5. Paint shall conform to IS: 2932. The pumps and engine shall be painted after installation with a coat of approved paint to similar shade as per original supply.

5.3. APPROVAL BY LOCAL BODIES
It shall be the responsibility of the contractor to obtain the approval of drawings and to get the installation inspected and approved by the concerned authorities as may be necessary as per local bye-laws.

6. TECHNICAL SPECIFICATIONS FOR SPRINKLER SYSTEM
All the piping for sprinkler work shall be with MS Class C & shall conform to IS 1239/3589.

6.1. SPRINKLER HEADS
Side wall/Pendant/Upright sprinklers to be provided as per requirements which shall be quick response type, shall be UL & FM certified, complete with rosette plate, glass bulb temperature rating of 68 degree Celsius (red color), Quick response type, chrome plated finish & in compliance with NBC 2016 & relevant IS codes. Wherever false ceiling is there, upright sprinklers to be provided at requisite distance as per codal provisions.

1) TYPES
   i. CONVENTIONAL PATTERN
      • The sprinklers shall be designed to produce a spherical type of discharge with a portion of water being thrown. The sprinklers shall be suitable for erection in upright position or pendant position. The designing of installation will be as per IS 15105.
   ii. SPRAY PATTERN
      • The spray type sprinkler shall produce a hemispherical discharge below the plane of the deflector.
   iii. CEILING (FLUSH) PATTERN
      • These shall be designed for use with concealed pipe work. These shall be installed pendant with plate or base flush to the ceiling with below the ceiling.
   iv. SIDE WALL SPRINKLERS
      • These shall be designed for installation along with the walls of room close to the ceiling. The discharge pattern shall be similar to one quarter of sphere with a small proportion discharging on the wall behind the sprinklers.

2) CONSTRUCTION
   • BULB: - Bulb shall be made of corrosion free material strong enough to withstand any water pressure likely to occur in the system. The bulb shall shatter when the
temperature of the surrounding air reaches a predetermined level.

- **VALVE ASSEMBLY:** - Water passage of the sprinkler shall be closed by a valve assembly of flexible construction. The valve assembly shall be held in position by the quartzoid bulb. The assembly be stable and shall withstand pressure surges or external vibration without displacement.

- **YOKE:** - The yoke shall be made of high quality gun metal. The arms of yoke shall be so designed as to avoid interference with discharge of water from the deflector. The sprinkler body shall be coated with an approved anti-corrosive treatment if the same is housed in corrosive conditions.

- **DEFLECTOR:** - The deflector shall be suitable for either upright or pendent erection. The deflector shall be designed to give an even distribution of water over the area protected by each sprinkler.

3) **COLOR CODE**

The following color code shall be adopted for classification of sprinkler according to nominal temperature ratings:

<table>
<thead>
<tr>
<th>Sprinkler Temperature Rating</th>
<th>Color of the Bulb</th>
</tr>
</thead>
<tbody>
<tr>
<td>68 deg. C</td>
<td>Red</td>
</tr>
</tbody>
</table>

4) **SIZE OF SPRINKLERS ORIFICES**

The following sizes of sprinklers shall be selected for various classes or hazards.

- **Moderate hazard:** 15 mm nominal bore

5) **STOCK OF REPLACEMENT SPRINKLER**

The following spare sprinklers shall be supplied along with the system free of cost to be treated as spare.

- **Moderate hazard systems:** 24 sprinklers

6) **TEMPERATURE RATING**

For normal conditions in temperature climates rating of 68 deg. C shall be used. However the temperature rating shall be as closed as possible to, but not less than 30 deg. C above the highest anticipated temperature conditions.

7) **DISTANCE B/W SPRINKLERS, ZONING, LEAKAGE ARRESTING ETC**

- Maximum & Minimum Distance between sprinklers, between sprinklers & boundary wall shall be as per hazard classification of building & relevant IS codes.
- Zoning of sprinklers with ICV to be placed in Plant Room in required buildings to be done as per relevant IS codes/NBC 2016/CPWD specifications. The sprinkler provision is to be considered shall be with min. one independent ICV.
- In order to avoid any kind of leakage from sprinklers, it shall be wound with Teflon tape & any other suitable water resistant sealing material.
- All measures to be considered so that sprinkler bulb is cleaned & free from any blemishes.
- Sprinkler type (pendant/upright/sidewall) shall be conforming to requirements & relevant IS codes.

6.2. **PIPES AND FITTINGS**

a. **PIPES**

- Pipes less than 25mm dia shall not be used and shall be Black Steel conforming to IS: 1239 (Heavy Class) upto 150mm.
• Welded Black Steel Pipe, Heavy Class conforming to IS:3589 for size greater than 150mm.
• Fittings for black steel pipes shall be malleable iron suitable for welding or approved type cast iron fittings with tapered screwed threads.

b. JOINTING
Joint for black steel pipes and fittings shall be metal to metal tapered thread or welded joints. A small amount of red lead may be used for lubrication and rust prevention in threaded joints. For Pipe size upto 50mm, Thread Joints are to be considered and for Pipe size above 50mm, Welded joints are to be considered.
Joints between MS pipes, valves and other appurtenances, pumps etc. shall be made with M.S. flanges with appropriate number of bolts. Flanged joints shall be made with 3mm thick insertion rubber gasket.

c. 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.
• Pipes in chase or buried underground shall be painted with two coats of hot bitumen, wrapped with bituminous Hessian cloth and finished with one coat of hot bitumen paint.

d. PIPE SUPPORTS
All pipes shall be adequately supported from ceiling or walls from existing inserts by structural clamps fabricated from M.S. structural e.g. rods, channels, angles and flats. All clamps shall be painted with one coat of red and two coats of black enamel paint. Where inserts are not provided, the contractor shall provide anchor fasteners.

e. ORIFICE FLANGES
Contractor shall provide orifice flanges fabricated from 6mm thick Brass plates on the branch lines feeding different zones/ floors so as allow required flow of water at 3.5 kg/ sq.mm pressure. The contractor shall furnish design for these orifice flanges.

f. Valves
Butterfly or Sluice valves of size 80mm and above shall be double-flanged cast iron conforming to IS: 780. Check valve shall be of cast iron double flanged conforming to IS: 5312. Valves on pipes 65mm and below shall be heavy pattern gunmetal valves with cast iron wheel seat tested to 20 kg/ sq.mm pressure. Valves shall conform to IS: 778.

g. Drain Valves
Black steel pipe of 50 mm dia conforming to IS: 1239 heavy class with 50 mm gunmetal full way valve for draining water in the system in low pockets.

6.3. INSTALLATION CONTROL VALVE:-
Installation control valves shall comprise of the following.
• One main stop valve of full way pattern with gunmetal pointer to indicate where open/ shut
• One automatic alarm valve, fitted with handle and cover.
• One hydraulic alarm motor and gong for sounding a continuous alarm upon outbreak of fire.
• One combined waste and testing valve including 5 meter of tubing and fittings
• Alarm stop valve
• Strainer
• Drain plug
• Padlock & strap
• Wall box for installation of valve

6.4. **ZONAL CONTROL VALVE** :-

Zonal Control Valve Assembly shall comprise of the following:

a. Butterfly Valve
b. Non-Return Valve
c. Flow Switch
d. Pressure Gauge
e. Drain Valve
f. Sight Glass
g. Necessary MS piping

Flexible connection for sprinklers shall be braided type of various lengths as per site requirements & shall be UL listed & FM approved.

6.5. **ANNUNCIATION SPRINKLER PANEL**

The equipment for control panel should be compact neatly wired and enclosed in a suitable 2 mm M.S. sheet that is suitably treated against corrosion. The control panel should be painted with enamel paint. The panel shall consist of:

a. Panel should be made in a module of suitable nos. of zones e.g. each module will have audible and visual indications and will monitor the circuit conditions with 24V DC battery.

b. The circuits provided in the control panel for each zone shall indicate the following conditions:
   i. Open Circuit in zone wiring
   ii. Short Circuit in zone wiring
   iii. Normal conditions
   iv. Power failure
   v. Low battery

c. The Automatic annunciation panel shall suitable for operation on 24V DC and shall be provided with power supply unit suitable to operate on A.C. mains of 230 V with a variation of 10%. The system shall be so designed that in case of failure of A.C. main supply it shall automatically change over to battery supply.

d. Suitable protection may be provided against charging of the battery over and above the specified values.

7. **PRESSURE GAUGES**

It shall be provided at the following locations.

a. Just above alarm valve
b. Just below alarm valve, on the installation stop valve
c. On the Wet Riser in every Fire Hose Cabinet Shaft.
d. Any other location as per requirement.
8. INSTALLATION OF PIPING
A. BELOW GROUND PIPING:
Underground piping should be installed in masonry trenches with cover or reinforced concrete. The pipe work shall be supported at regular intervals of 2.5m with masonry or RCC supports. All pipes shall be protected against corrosion with two coats of bituminous painting and wrapped with pykpote or bitumen Hessian cloth and finish with one coat of hot bitumen paint.
B. ABOVE GROUND PIPING:-
a. All above ground piping shall be installed on suitable pipe hangers/ supports as required. The hangers shall be made of MS angles, channels, channels etc. and painted to the required finish (with suitable synthetic enamel paint). The spacing supports shall be as follows.
   i. 25 mm - 50 mm dia.  1.5mtr.
   ii. 65mm – 100mm dia.  1.75 mtr.
   iii. Above 100mm  2 mtr.
   iv. Vertical Piping  2 mtr.
   a. Piping shall be screwed type up to 50 mm dia. Welding of joints will be allowed for pipes of 65mm mm of larger diameters.

9. TESTING & COMMISSIONING:-
12.1.1 PRESSURE TESTING OF PIPES
During laying of pipes, the same shall be subjected to 10 Kg/cm2 hydraulic pressure for a period of 24 hrs., in sections. After completion of the work, all valves/fittings shall be installed in position and entire system shall be tested for 24 Hrs. at a pressure of 10 Kg/cm2. The drop of pressure up to 0.5 Kg/cm2 shall be accepted. The pressure Testing may be carried out by means of Electric Driven Pump or manually operated Test Pump.
All leaks and defects in different joints, noticed during the testing and before commissioning shall satisfaction of engineer.
Testing of fittings/ equipment shall be carried out either at site or at works in the presence of a representative of the engineer. Test certificates shall also be furnished by the contractor.
The automatic operation of the system and alarms for the various functional requirements, as laid down in this specification, shall be satisfactory carried out in the presence of Engineer-in-charge.
12.1.2 INTERNAL HYDRANT/SPRINKLER & EXTERNAL HYDRANT SYSTEM:-
After laying and jointing, the entire piping shall be tested to hydrostatic test pressure. The pipes/sprinkler heads shall be slowly charged with water so that the air is expelled from the pipes. The pipes shall be allowed to stand full of water for a period of not less than 24 hours and then tested under pressure. The test pressure shall be 12 kg/cm2. The test pressure shall be applied by means of manually operated test pump or by a power driven test pump to be provided by the contractor. The Lines shall be flushed before completion of building work so that any foreign matter which might have entered the system is taken out. The Jockey Pump should be operated and Valves must be open at different locations.
After completion of work, all valves/ fittings shall be installed in position & entire system shall be tested for 24 hours at a pressure of 10 kg/cm2. The drop of pressure upto 0.5 kg/cm2 shall be accepted.
12.1.3 FINAL TESTING
After completion, all operation checks shall be carried for automatic operation of system including flow test. The exercise shall be repeated couple of time to ensure trouble free operation.

COMMISSIONING:- Before commissioning, entire system be flushed properly. As soon as the work is completed the system shall be commissioned and made available for use. If required, isolate the system of under construction portion of the buildings.
For automatic operation sprinkler system by using inspection testing valve. In this case annunciation panel of that particular zone and mechanical gong valve should work.
Overhead Tanks shall be so designed so that the Pipe Inlet & Outlet Spout of Tank and the opening lid is not at the same level so as to ensure smooth filling of Tanks and subsequent overflow.
All other testing & commissioning methods to be adopted & performed as per relevant IS Codes/CPWD Specifications & NBC 2016 norms.

12.1.4 PAINTING
Painting of the entire wet riser piping & sprinkler piping over the ground shall be done with 1 coat of anticorrosive primer and 2 or more coats of approved paint till the satisfaction of engineer-in-charge ensuring that one coat of paint is done after final painting of the pump house & buildings. The color shall be post office stove enameled red with shade No. 536 of IS: 5, Paint shall also conform to IS:2932. The pumps/ engine shall be painted after installation with a coat of approved paint to similar shade as per original supply.
CHAPTER- 15
TECHNICAL SPECIFICATIONS- STP, ETP, WTP and Portable RO Works

a. PORTABLE WATER PURIFIER
   • Design, Supply, installation, testing & commissioning of Portable RO with water cooler of required storage capacity & water flow rate 50 LPH through faucets including RO membrane, pumps, motors, cartridge filters, interconnecting pipes, valves, cable etc. along with water cooler facility.
   • It shall be provided with adjustable cold water thermostat, seam welded food grade stainless steel tank, pre coated outer body, mechanically expanded condenser, overload compressor protection, sturdy compressor & trouble free operation, insitu power saving PUF insulation, no. of faucets (min. 2), 7 stages of filtration(approx.) with speedy drainage facility.
   • The refrigerant shall be ecofriendly & the unit shall be silent operation type. The operating temperature shall be between 15 to 45 degree C.
   • It shall be provided with auto flush feature.

b. MATERIALS:
   • The Portable Water Purifier shall have PP meltdown sediment filter, activated carbon block, thin film composite spiral wound type reverse osmosis membrane, ultra violet membranes, diaphragm type pump, suitable for maximum 500 ppm hardness, 10 NTU turbidity, TDS of max 2000 ppm inlet water quality& a reduction upto 90% in TDS & Hardness parameters.
   • The purified water flow shall be approximately 9-12 LPH on average. The system shall be suitable for a supply of 100-240 V AC / 50 Hz. The Purifier shall be supplied with all equipment membranes, filters and pumps, motors, interconnecting pipes, adaptor and cable of minimum 1.8m length & complete in all respect.

EFFLUENT TREATMENT PLANT:
The specifications for ETP shall be as per DBR & as per directions of the Engineer –In Charge. The Contractor shall submit shop drawing illustrating the detailed piping & instrumentation details of entire ETP system, which shall be approved by HITES prior to start of execution work at site

a. SEWAGE GENERATION AND CHARACTERISTICS
It is based on Membrane (hollow fibre) technique.

Note: In case of any variation between the technical specifications & the BOQ, the BOQ shall be taken as final. GRIHA norms & relevant IS standards (output water for irrigation/flushing/sewer/portable) for output water parameters should be complied with.
SEWAGE TREATMENT PLANT

1.1 Basis of Design

1. The capacity/ rating of pumps and equipment etc. shall hold good for the required capacity and shall be good for meeting the treated parameters requirement as follows:
   g. Manufacturer, use import and storage and hazardous Micro-Organizers, Genetically Engineer-in-charge organizations or Cell Rules, 1989.
   h. Manual on sewage & sewage treatment - CPHEEO
   j. All standards as laid down by Central Pollution Control Board and any other relevant statutory authority.
   k. 100% recycle of waste water and removal of sludge in cake form, no water to be discharged outside to the premises.

1.2 General

The sewage treatment plant (STP) system outlined in this section specifies the system design, manufacture, supply and installation Testing & Commissioning of submerged hollow fiber based MBR (Membrane Bio Reactor) system acceptable to Water and Sanitation Authority Requirement, Local Pollution Control Board Norms, World Health Organization Guidelines, the local Environmental and Pollution Control Authorities and subject to the approval of the Engineer-in-charge.

The work shall be carried out in a manner consistent with good practice in the local...
market. The Contractor shall take into account all site conditions in designing the system and selecting the equipment.

The Contractor shall perform the system design based on the criteria/data and component technical requirements specified in this section/drawings and the local Authorities’ regulation/requirement.

The Contractor shall furnish system which comprises products of manufacturers who have designed and made these associated products for a period of at least five years.

The Contractor shall submit complete catalogue information, design calculation and samples complete with full technical data and shop drawings for the entire system, test certificates, etc. for acceptance prior to commencement of installation.

The Contractor shall submit analytical test reports of effluent water samples after the commissioning or after the system is put into operation or as required by the Engineer-in-charge:

(a) First 3 months – 15 days

The report shall contain analysis of all data related to those requirements laid down by the local Authorities.

As a minimum the following items shall be measured and analyzed as indicated under clause 2.1 following.

1.3 Design Criteria

It shall be the Contractor’s responsibility to ensure the quality of the treated effluent to comply with the local Authorities requirement and the following characteristics, whichever is stringent.

<table>
<thead>
<tr>
<th>Item of Analysis</th>
<th>Units in Milligram per litre or otherwise stated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Colour</td>
<td>7 Lovibond units</td>
</tr>
<tr>
<td>2 pH value</td>
<td>6 - 8.5</td>
</tr>
<tr>
<td>3 BOD (5 day at 20°C)</td>
<td>5</td>
</tr>
<tr>
<td>4 COD</td>
<td>&lt; 20</td>
</tr>
</tbody>
</table>
5. Total Suspended Solids < 50

6. Grease and Oil Below detectable level

<table>
<thead>
<tr>
<th>Item of Analysis</th>
<th>Units in Milligram per litre or otherwise stated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphate (PO₄)</td>
<td>1</td>
</tr>
<tr>
<td>E-coli</td>
<td>Nil</td>
</tr>
<tr>
<td>Turbidity (NTU / JTU)</td>
<td>&lt; 1</td>
</tr>
</tbody>
</table>

The effluent from the Sewage Treatment Plant shall be suitably treated and the effluent water recovered shall be used for flushing, irrigation and Cooling Tower make-up.

1.4 Description of Process

The treatment process shall comprise the following stages:

**For MBR System**

- Physical treatment: coarse & Fine bar-screening
- Primary treatment: Oil & Grease Trap & Grit Chamber
- Equalization tank: flow equalisation with airmixing
- Biological treatment: Aeration With MBR
- Disinfection: UV unit with chlorination system as standby
- Digester: aerobic digestion with diffused air system
- Water reclamation: tertiary filtration and Softening (for C.T cooling purpose)

- Sludge disposal: sludge chemical conditioning and dewatering

The biodegradable detergent will be discharged into the Sewage Treatment Plant. The Contractor shall provide the special equipment, etc. and defoaming agent for the treatment of the detergent such as providing the froth pump to remote the foam and FeCl₃ for phosphate removal.

1.5 Performance Criteria of the Plant
Raw sewage will be brought into the Sewage Treatment Plant. The Contractor shall receive sewage from this point to the treatment plant for treatment process.

The treatment plant shall be designed to treat the following basic characteristic expected in the raw sewage.

i. Capacity (Max): 105 M$^3$/Day (100 KLD Sewage + 5 KLD Treated Effluent)

ii. Operation: Domestic Sewage (round the clock)

iii. Incoming Influent

a. pH - 6.0 to 8.5
b. BOD 5 days @ 20 deg. C. - 250 to 500 mg/l
c. Suspended solids (SS) - 250 mg/l
d. Oil & grease - 50 to 100 mg/l
e. COD 5 - 450 to 750 mg/l

iv. Final Effluent after filtration

a. pH - 6-8
b. BOD 5 days @ 20 deg. C. - Less than 5 Mg/L
c. Suspended solids (SS) - Less than 50 Mg/L
d. COD - Less than 20 Mg/L
e. Oil & grease (after grease trap) - Below detectable level

Treated effluent shall be connected to a tertiary filtration / treatment and shall be treated for use for flushing, irrigation and cooling tower make-up purpose. The Contractor shall carefully consider the operation loading for the Sewage Treatment Plant.

1.6 Process Description

**For MBR System**

The out fall sewer main from the last manholes, will be let into a screening chamber by gravity flow. Large solids particles shall be intercepted by a bar screen, preceded by a grease trap. The primary clarified wastewater is then further pre-treated by fine screening before entering the bioreactor portion of the MBR process. Fine screening shall be done by proposed bar screen.

a. The sewage after screening is collected in a oil & grease trap after that goes-in to grit
chamber & finally to the equalization tank for smoothing out peak flows. This tank is sized to accommodate peaks, as well as breakdown buffer. The provision of air shall be kept in this tank to break the solids in suspension and to homogenize the sewage.

b. The homogenized effluent is then pumped into the Biological reactor for the removal of BOD, COD, Phosphate and Nitrates. The reactor is equipped to perform suspension growth of microorganism (Mixed Liquor) in 12000-15000 MLSS. The air shall be provided through an air diffusion system all round the membrane to soccer the sludge & for biological treatment of sewage in the reactor.

c. The mixed liquor suspended solids from the bioreactor is then transferred to the submerged hollow fibre based membrane tank consists of S.S housing, air diffusion system, permeate water manifold & membrane elements. U.F. membrane (0.1 micron pore size) system shall be work to separate the sludge and the treated effluent. The treated water passed through U.V unit for disinfection purpose and stored in a Clear water tank for further reuse.

d. Depending on the MLSS to be retained in the Biological reactor the sludge is wasted. The wasted sludge is collected in sludge thicker and aerated with diffused aeration and then sludge shall be feed to filter press where sludge shall be collected in the form of Cake for manure use & primate shall be send back to equalization tank.

e. To avoid the membrane to get chocked due to bacteria generation in membrane & organic substance, chemical cleaning (CIP) shall be carried out on regular intervals as required for removing substances polluting and clogging the membranes. Normal cleaners used are sodium hypo chloride and citric acid.

1.7 Equipment

The following give the minimum requirements of the different components of the system. The figures indicated are for contractor's references. It shall be the Contractor’s responsibility to select equipment for the plant proposed by them so that the capacities and performance of the Sewage Treatment Plant meet with the criteria set out in this specification.

All equipment and components of the system shall be of top quality construction and shall be corrosion resistant.

1.8 Inlet Screen Chamber

Raw sewage shall flow into the inlet screen chamber by gravity. Large solids particles shall be intercepted by an Coarse & fine step screen. A manual screen shall be installed
in parallel with the screw screen as a standby screen when the step screen is under maintenance.

1.9 Equilization Tank

The equalization tank shall be designed to provide a minimum storage of 3 hours at peak flow while pumping. Two submersible pumps as per schedule shall be provided with level switch control and automatic cut-in of the standby unit.

An aeration system similar to the extended aeration tank shall be provided for mixing and aerating the sewage.

1.10 Air Blowers

Air blowers shall be provided in duplicate (i.e. one duty and one standby). Blowers shall be either of positive displacement or centrifugal with pressure vessel type complete with motor, base-plate, inlet filter, intake silencer and off-load starting system outlet silencer, anti-vibration damper, flexible coupling, filter restriction indicator, non-return valve, pressure relief valve, V-belt system or direct drive coupling. The casing rotor shall be of cast iron construction. Bearings and gears shall be grease lubricated. Motor speed shall be not less than 1500 rpm.

The size and performance of the air blower shall be so selected that it can provide a minimum air flow rate 0.4 l/sec / diffuser to 1l/sec/diffuser maximum, and to maintain a minimum of 2.0mg/liters dissolved oxygen in the aeration tanks in operation.

1.11 MBR Tank

Sewage shall be retained in MBR tank subjected to biochemical oxidation by fine bubbles aeration.

1.12 Air Diffusers for Equalization, Sludge holding tank

Air diffusers shall be made to provide a uniform distribution of fine bubble air release performance in the system. The air diffuser shall be either made of elastomic rubber membrane or composed of crystalline fused aluminium oxide with a suitable ceramic bonding material.

Membrane endurance shall be more than 180,000 expansion/contraction cycles.

Diffuser shall be of self-cleaning, non-clog disc or dome-shaped type. Oxygen transfer efficiency shall not be less than 20% at 3.5m submergence in clear water. Alternatives
Diffuser hold down assemblies shall consist of a retainer bolt, a matching washer and gasket. Sealing gasket shall be composed of solid neoprene rubber and shall be conform to ASTM D-2000 and shall be suitable for withstanding the effects of wastewater high temperature up to 120°C.

The Contractor shall submit calculation to justify the diffuser selection and air requirement during the detailed design.

1.13 Membrane Module:

Membrane module shall be comprising of housing of membranes, aeration diffusers, primate water manifold membrane element.

Membrane should be combined in to bundles wound a carrier cartridge which can allow for high pressure air scouring for cleaning.

Membrane should have maximum 0.03 Micron size but pore hole may be as per manufacturer specifications

1.14 Disinfection Tank

Waster shall be passed through UV unit for disinfection, as standby measure chlorine solution shall be metered in to the effluent by an electric dosing pump paced according to the sewage inflow. The effluent shall be retained in the baffle walled chlorine tank for a minimum of 30 minutes for effective disinfection prior to discharge.

1.15 Sewage feed, sludge transfer & permeate suction Pumps

Working and standby sewage pumps shall be provided.

Each shall be of non-submersible type centrifugal pump with suction grid and automatic discharge connection. Pump casing and impeller shall be of cast iron material. Shaft shall be of CS material. The BOQ identifies quote rate for alternate MOC. (Contractor to ensure submission of quote for same).

1.16 Sludge Transfer and Disposal Pumps

Two numbers of sludge feed pumps to filter press (one duty and one standby) shall be provided.
Each shall be of screw type pumps. The material construction shall be the same as the sewage pumps.

1.17 Chlorination System (Standby System)

A chlorine contact tank with a capacity of not less than 30 min average flow detention shall be furnished. It shall be attached to the settling tank. Construction shall be similar to the other tanks and panels comprising the treatment plant, and shall include flow diversion baffles and outlet of the chlorine contact chamber for measuring the waste flow.

A chlorine feed system shall be furnished as a complete package assembly for installation in the plant room. Assembly shall include base plate, electronic positive displacement type chemical feed pump, fibreglass solution tank, suction and discharge tubing and fittings.

Each chlorine solution dosing pump shall perform to achieve a residue not more than 1 mg/l in the treated effluent. Solution feed pump shall have a maximum capacity of 1 l/hr chemical pump will operate on 50 Hz supply. Fiberglass solution tank shall be of no less than 200 litre capacity and include suction line fitted with strainer.

Control shall be by means of compound loop (i.e. flow proportional and residual measuring).

The feed pump shall be of variable speed positive displacement, solenoid-riven diaphragm metering type. The construction material shall be suitable for corrosive nature and as follows:

1.18 Tertiary Treatment

This tertiary treatment shall be provided for the effluent used for irrigation and cooling tower make-up water tank/flushing system.

The tertiary treatment plant shall comprise of the softener with brine to achieve hardness less than 5 ppm. This shall be sized to accommodate 100% of the effluent discharge flow rate and shall achieve the performance as outlined and described in Design Criteria.

Details of the equipment layout proposal shall be submitted for review by the Engineer-in-charge with tender documents.
1.19 Treated Water Transfer Pumps /Softener Feed Pumps /Soft Water Transfer Pumps

Working and standby Treated/ Soft Water Transfer pumps shall be provided.

1.20 UV Unit / System

UV system for disinfection shall utilize high purity quartz sleeves and high output UV lamps. UV Reactor MOC will be SS316L. System shall be designed to provide a UV dose of 600 J/m2 at UVT of 65% and TSS less than 10 mg/L. System should deliver a 4 log reduction of coliforms and provide TC count to less than 200 CFU/100ml. The electrical control system should utilize high frequency electronic ballasts and provide efficiency of more than 90%. The reactor vessel shall utilize internal baffles to ensure turbulent and plug flow.

The UV intensity monitoring system shall be designed in accordance with the German DUGW W294 standard. The sensor shall be of dry type and removable without system shutdown.

The tertiary treatment plant shall comprise of the pressure sand filters and activated carbon filters. This shall be sized to accommodate 100% of the effluent discharge flow rate and shall achieve the performance as outlined and described in Design Criteria.

Details of the equipment layout proposal shall be submitted for review by the Engineer-in-charge with tender documents.

1.21 Electrical Control

The operation of the treatment process shall be fully automatic.

A completely assembled and prewired control panel with mimic diagram consisting of weatherproof cabinet shall be furnished. The control panel shall contain all metering and status indicators, motor starters, program timbers, on-off-auto change-over switches and duty selectors for equipment.

Proper control sequence shall be designed according to system requirement and manufacturer standards,

1.22 Other Equipment

Any other necessary accessories, such as buffer, riser, partition, control panel, collection devices, etc. for all the tanks and pumps (where necessary) shall be provided in order
to provide a fully working systems.

1.23 Piping Materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS304</td>
<td>Submerged air piping</td>
</tr>
<tr>
<td>MS epoxy</td>
<td>Air piping and pumped effluent riser (Non submerged)</td>
</tr>
<tr>
<td>PVC piping</td>
<td>Pumped effluent (submerged) &amp; tank overflow pipe line.</td>
</tr>
<tr>
<td>GI (Heavy)</td>
<td>Interconnecting pipe line after delivery header of pump / filter.</td>
</tr>
</tbody>
</table>

1.24 Valves

The Contractor shall supply and install all isolating valves and control valves as indicated on the drawings and as required for the proper and efficient operation and maintenance of the entire systems.

All valves supplied shall be suitable for the working pressure and test pressure of the system as specified elsewhere in this specification.

Regulating valves shall be of similar materials as that specified for cast iron gate valves.

All regulating valves shall be lock shield type.

All valves shall be full line size.

Each valve shall have a purpose made reference number plate for label engraved or stamped indicating the manufacturer's catalogue number, pressure and temperature ratings. Valves shall be arranged so that clockwise rotation of the spindle will close the valve. Dymo labels are not acceptable.

Furnish all valves and accessory materials necessary in the piping whether or not shown on drawings as flows.

All valves shall be packed with an approved packing and threads shall be coated with oil and graphite. Packings should be replaced when found deteriorated on site.

Where possible locate all valves at convenient positions of operation from the floor with valve stems upright.

Valves that are flanged shall have flanges to the table specified for the pipe work.
Plastic or metal plates (rustless) shall be provided to indicate the open / close status as well as the use of each valve in the pump and tank rooms.

Intrudence clause of pipe support here.

1.25 Pipe Supports

**General Support**

Tender drawings indicate schematically the size and location of pipes. The Contractor, on the award of the work, shall prepare detailed working drawings, showing the cross-sections, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air valves, and all pipe supports. He must keep in view the specific openings in buildings and other structure through which pipes are designed to pass.

Piping shall be properly supported on or suspended from, on stands, clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchor, clamps and hangers, and be responsible for their structural stability.

Pipe work and fittings shall be supported by hangers or brackets so as to permit free expansion and contraction. Risers shall be supported at each floor with Galvanised steel clamps. To permit free movement of common piping support shall be from a common hanger bar fabricated from Galvanised steel sections.

Piping shall be supported from the building structure, which shall support the sum of the load of a water-filled pipe and a minimum of 120 kg applied at the point of hanging.

All piping brackets shall be constructed as shown on the standard detail drawings.

Vertical pipe work shall be supported at intervals of at least one per floor level.

Horizontal pipe work shall also be supported by adjustable flat iron or clevis type hangers hung by hot rolled steel rods of the following diameters and spacing subject to the Architect’s approval:

<table>
<thead>
<tr>
<th>Nominal Pipe Size</th>
<th>Distance between Supports</th>
<th>Rod Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mm</td>
<td>1.8 m</td>
<td>10</td>
</tr>
<tr>
<td>32 mm</td>
<td>2.4 m</td>
<td>10</td>
</tr>
<tr>
<td>40 mm</td>
<td>2.7 m</td>
<td>10</td>
</tr>
<tr>
<td>50 mm</td>
<td>2.7 mm</td>
<td>10</td>
</tr>
<tr>
<td>65-80 mm</td>
<td>3.0 m</td>
<td>12</td>
</tr>
</tbody>
</table>
100 mm 3.0 m 16
150-200 mm 3.6 m 18

The end of the steel rods shall be threaded and not welded to threaded bolt.

Hangers shall be supported by means of approved fasteners. Wood plugs shall not be used. Unless allowed by the structural Engineer-in-charge, power fixings may be used for pipe work of diameter less than 50 mm. Expansion fasteners may be used for vertical pipe work under 100 mm diameter.

All pipe work shall be carried out in a proper workman like manner, causing minimum disturbance to the existing services, buildings, roads and structure. The entire piping work shall be organized in consultation with other agencies work, so that area can be carried out in one stretch.

Requirement of Cut-outs in the structural slab or wall for installing the various pipes shall be clearly identified in the detailed shop drawing to be prepared by the STP contractor.

Pipe sleeves, larger diameter than pipes, shall be provided wherever pipes pass through walls and slab and annular space filled with fiberglass and finished with retainer rings.

The contractor shall make sure that the clamps, brackets, saddles and hangers provided for pipe supports are adequate or as specified / approved by Consultants. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.

All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reduces shall be used for the piping to drain freely. In other locations, concentric reduces may be used.

Automatic air valves shall be provided at all high points in the piping system for venting. All valves shall be of 15mm pipe size and shall be associated with an equal size gate valves. Discharge from the air valves shall be piped through a pipe to the nearest drain or sump. All pipes shall be pitched towards drain points.

Pressure gauges shall be provided as shown on the approved drawings. Care shall be take to protect pressure gauges during pressure testing.
1.26 Installation

The Contractor shall check the associated civil work prior to the installation of any item of machinery and advise the Engineer-in-charge, in writing, of any deviation of such work from the specified details.

The machinery shall be accurately installed to correct dimensions, alignments, levels, etc., all as indicated on the final drawings. The machinery shall be mounted on flat steel packing pieces of thickness suitable to take up variations in level of the concrete foundations. Suitable packing pieces shall be located adjacent to each holding down bolt and shall be properly bedded by grinding the concrete surface to a smooth, level finish. The machinery shall be aligned and levelled and the nuts of the holding down bolts tightened with a spanner of normal length. The base plates shall be packed with grout after the machinery has been run and checked by the Engineer-in-charge for stability and vibration.

Installation shall include the provision and fixing of all necessary holding down bolts, washers, nuts etc.

The length of all bolts shall be such that when fitted with a nut and tightened the threaded portion of the bolts shall protrude from the top face of the nut by a distance not exceeding half the bolt diameter. Exposed bolt heads and nuts shall be hexagonal.

All equipment and materials of the same type shall be products of the same manufacturer. Locally made equipment will not be accepted unless otherwise specified.

All similar items of plant and their component part shall be completely interchangeable. Spare parts shall be manufactured from materials similar to the originals and shall fit all similar items of plant. Where machining may be needed before fitting renewable parts, the machining fits with their tolerance shall be shown on the drawings accompanying the instruction manuals.

All motors and/or revolving parts shall be truly balanced both statically and dynamically so that when running at normal speeds and any load up to the maximum there shall be no significant vibration due to lack of balance. All parts which can be worn or damaged by dust shall be totally enclosed in dust-proof housings.

1.27 Maintenance Facilities

Permanent work platform and catwalk shall be designed by the Contractor and provided by the Contractor for access to elevated equipment. The catwalk and platform for access shall allow a minimum width of 750mm.
Catwalk to maintenance platform shall be provided with railings and guards designed for safe movement of personnel in a restricted space including provision for gaining access and to accommodate maintenance personnel.

Hand railing and guards shall be designed by the Contractor and provided by the Contractor for all concrete tanks to allow safe movement of personnel.

Permanent I-beams, lifting eyes, etc. shall be provided by the Contractor over major equipment which require lifting for overhaul and maintenance.

Waterproof power sockets required for servicing shall be provided by the Contractor. The number and locations shall be proposed by the Contractor and approved by the Engineer-in-charge/Engineer-in-charge. Power supply to these sockets shall be taken from control panel of the sewage treatment system.

The design of all permanent work platform, hand rails, etc. shall be submitted to the Engineer-in-charge/Engineer-in-charge for approval. The loading and fixing method of lifting facilitate shall also be submitted to the Engineer-in-charge/Engineer-in-charge for approval and checking within 4 weeks on award of Contract or receipt of letter of intent.

1.28 Testing

The performance of the system shall be demonstrated by taking hourly samples of the raw sewage and final effluent over a twelve hour period. The sample shall be taken at periods approximately the flow rates specified by the plant. The sample shall be combined and a 5-day BOD shall be run, the results of which must verify the capacity of the treatment plant prior to acceptance.

1.29 Training

Provided training facilities courses to ensure that the employer's staff associated with the project may acquire full knowledge and appreciation of all aspects of the design, day-to-day operation, breakdown and routine maintenance, and fault diagnosis of all plant, equipment and systems.

Training to the employer's staff shall be held as appropriate at the Contractor's or manufacturer's premises and on site. A detailed syllabus for each of the training courses specified or proposed and the timing of the courses shall be submitted for approval. The Contractor shall recommend the desirable qualifications and experience of the trainees to optimally benefit from the courses.
The Contractor shall be deemed to have include in his tender price the cost of providing training facilities as specified.
In addition to the above, the Contractor shall submit to the Engineer-in-charge a list describing such other spares and special tools, their number, price and where appropriate the anticipated frequency of replacement as soon as is practicable.

**SECTION 3: WTP PUMPS & EQUIPMENTS**

1. **PUMPS AND WATER TREATMENT EQUIPMENT**

   1.1 Work under this sub-head consists of furnishing all labour, with appropriate T&P scaffolding & staging as required to completely install pumping system for various water supply services and water treatment as per drawings, specified hereinafter and given in the Bill of Quantities.

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

   a) Raw water pumps.
   b) Domestic water supply Pumping System.
   c) Garden Water Supply Pumps.
   d) Booster Pump Sets
   e) Sump pumps for disposal from drainage and sewerage sumps for Plant rooms / Basements etc.
   f) Water treatment units consisting of filters, softening plant, chlorination etc.
   g) Level Control & indication System
   h) Motor control panels, power and control cabling and allied electrical works.
   i) Pipes, valves, accessories, hangers, supports, delivery and suction feeders and connection to proposed pipe work.

2. **RE-LIFT WATER SUPPLY PUMPSETS**

   2.1 Water supply pumps shall be suitable for clean water. Pumps shall be single or multistage, mono block horizontal/vertical, centrifugal pumps, motor rating IE -3, with cast iron/stainless steel body and stainless steel/bronze impeller, stainless steel shaft and coupled to a TEFC electric motor by means of a flexible coupling or as specified in bill of quantities. Each pump should operate a curve 10m below specified head.

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

   2.3 Each pump shall be provided with a totally enclosed fan cooled induction motor of required H.P. and RPM specified in the bill of quantities and as per requirement.

   2.4 Each pumping set shall be provided with a 150mm dia or of suitable size gunmetal “Bourden” type pressure gauge with gunmetal isolation cock and connecting piping.
2.5 Each pump shall be provided with vibration-eliminating pads as suitable for each pump.

2.6 Each pump-set shall be provided with flow measuring meter with bypass arrangement as per requirements and instructions of the engineer-in-charge. (Flow meter items shall be paid for separately as per relevant BOQ item).

2.7 All water supply pumps shall be provided with mechanical seals, of required specifications.

2.8 Installation

Pump shall be installed as per manufacturer’s recommendations. Pump sets shall be mounted on machinery isolation cork or any other equivalent vibration isolation fitting. The vibration isolation pads, foundation bolts etc. shall be supplied by the Contractor. Contractor shall ensure that the foundation bolts are correctly embedded.

Pump-sets shall preferably be factory aligned, wherever necessary, site alignment shall be done by competent persons.

2.9 Testing

Contractor shall submit all the performance curves of the pumps supplied by them. They shall also check the capacity and total head requirements of each pump to match their own piping and equipment layout. On completion of the entire installation, pumps shall be tested, wherever possible, for their discharge, head, flow rate, B.H.P. Where it is not possible at least the discharge, head and B.H.P. (as measured on the input side) shall be field tested. Test results shall correspond to the performance curves.

2.10 Painting

After complete installation and testing, pumps accessories and fittings shall be given two coats, three mils each of approved finishing paint.

3. SUMP PUMP

3.1 Sump pumps shall be submersible type for lifting domestic sewage or muddy water/drainage as specified in Bill of Quantities. Pump with impeller of approved material and design shall be mounted on waterproof motor. The impeller shall be suitable for handling solids as specified in Bill of Quantities.

3.2 The pump shall automatically operate with high water level and stop at low water level in the sump by means of “Electronic Level Controller”, of the approved make as per manufacturer compatibility.
3.3 The sump pumps shall be complete in all respects and shall be installed as per manufacturer’s requirement as shown in the drawing. All accessories shall be In-Built as per manufacturer’s specification.

3.4 All pumps within a pump set shall run in cyclic fashion under normal operating circumstances. All pumps within a pump set shall be capable of operating simultaneously / cumulatively in case of emergency / high water level.

4. **WATER FILTER**

4.1 Water filter shall be of dual media pressure filter of downward or upward flow type suitable for a rate of filtration given in Schedule of quantities.

4.2 Filter shall be vertical type of required diameter. The shell shall be fabricated from M.S. plate suitable to withstand a working pressure of 5 Kg/cm². The minimum thickness of shell will be 8mm and dished ends shall be 10mm. The quality of Steel shall be as per IS:2062 Grade B, thickness as per ASME Section 8. The filter shall have at least one pressure tight manhole cover.

Filter shall be provided with screwed or flanged connections for inlet, outlet, individual drain connections and all other connections necessary as required. Filter shall be painted inside with two or more coats of coal tar epoxy paint, one coat of red oxide primer outside with two or more coats of synthetic enamel paint of approved shade.

The Filter media shall comprise of 0.5 to 1.00 mm fine filtering silica sand for removal of turbidity and suspended matter.

The initial charge of filter media as specified in above para’s shall be the responsibility of contractor.

The pressure filter shall be complete with cleaning cycle controller adjustable to meet application requirement, actuating control valves in required sequence for back wash.

4.3 **Under Drain System**

Filter shall be provided with an efficient under drain system comprising of collecting pipes, gunmetal/polypropylene nozzles of manufacturer’s design. The entire under drain system be provided on M.S. Plate or cement concrete supports.

4.4 **Face Piping**

Filter shall be provided with interconnecting face piping comprising of inlet, outlet, and backwash pipe complete with pipes, valves and accessories, as per requirement. Piping shall be G.I. piping, heavy duty, as per I.S: 1239 and valves shall be cast iron double flanged sluice valves with C.I. body and Neoprene rubber diaphragm.

4.5 **Accessories**

Each filter shall be provided with following accessories:

- A. Air release valve with connecting piping.
B. 150mm dia dial bourden type gunmetal pressure gauges with gunmetal isolation cock and connecting piping on inlet and outlet.
C. SS Sampling cocks on raw water inlet and filtered water outlet.
D. Individual drain connection with gunmetal full way valve should be piped through a properly sized G.I. pipe to nearest drain point.

5. **WATER SOFTENER**

5.1 Softener shall be designed to give zero commercial hardness. Softener shall be with “cation” ION exchange resins.

5.2 Softener vessel shall be of mild steel plate with dished ends and self supporting arrangement. Vessel shall be suitable for a minimum working pressure of 5 Kg/ Sq. cm. The vessel shall be tested at 1.5 times the working pressure. The shell shall be designed to allow a minimum free board space at 50% of the mineral bed depth for adequate expansion during back washing. The shell shall have a minimum thickness of 8mm and dished ends 10mm. The quality of Steel shall be as per IS:2062 Grade B, thickness as per ASME Section 8. All internal parts of the softener shall be rubber lined as per approved specifications rubber lined and externally with one coat of red oxide and two or more coats of synthetic enamel paint of approved shade.

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

5.4 The softener shall have a set of interconnecting face piping consisting of inlet, outlet and brine injection system with valves and accessories complete as per requirement. Piping shall be G.I heavy duty, as per IS: 1239 and valves shall be cast iron double flanged sluice valves with C.I. body and Neoprene rubber diaphragm. Individual drain connection with gunmetal full way valve should be piped through a properly sized G.I. pipe to nearest drain point.

5.5 The brine injection system consist of hydraulic ejector with control valve, brine delivery pipes with adjustable indicator.

5.6 One measuring tank (Brine Tank) having a capacity of minimum one regenerations or as specified in bill of quantities.

5.7 One orifice board for indicating wash and rinse rate to be fitted in drain sump.

5.8 One initial charge of supporting gravel, sand and “cation” ION exchange resin in requisite quantity.

5.9 One water testing kit with instructions for testing water samples.

5.10 One rota meter to indicate flow rate.
5.11 Inlet & outlet pressure gauges.

6. **SALT SATURATOR ASSEMBLY**

6.1 Tanks shall in High density Polyethylene (HDPE) construction of required capacity. The assembly shall be suitable for holding and supplying salt for softener with inlet & outlet piping with valves and accessories complete as per requirement.

6.2 The assembly shall be provided with an automatic agitator. The automatic agitator shall be motorized (motor of suitable rating operating on single phase, 50 Hz, AC supply) having Stainless steel shaft with fan blade, coupled with suitable gear box duly mounted MS Frame with Epoxy Coating.

6.3 The transfer Pump for supplying salt solution to softener shall be of multistage, Inline vertical, centrifugal pumps with cast iron/cast steel body, SS316L stage casing, SS316L impeller, stainless steel shaft, and directly coupled with TEFC induction motor of class "F" insulation & efficiency class EFF-1, 2900 RPM, IP 55 enclosure, suitable for operation on 415 volts ±10%, 3 phase, 50 Hz, A.C. supply.

6.4 The contractor has to ensure that the effective capacity of the system shall be of minimum 10% greater than actual salt required for approx. 3 Days with complete structural arrangement including suitable foundation bolts & other accessories etc.

7. **CHLORINATOR**

Chemical dosing should consist of electronic / electro mechanical metering pumps with suction and delivery flexible connections and fittings. The pump shall be mounted on FRP tank of required capacity having in-built basket for holding alum blocks and lime blocks. The system should be completed with electrically operated single phase motor driven stirrer having stainless steel shaft. This should be suitable for working against a pressure of 1.5 kg/Sq.cm and should be capable of ejecting Sodium Hypo-chloride solution / suitable alternate chemicals with a dose of 1 ppm.

8. **PIPING**

8.1 Pipes for suction and delivery shall be galvanized steel pipes (heavy duty) confirming to I.S:1239 upto 150mm dia and as per I.S:3589 for dia 200mm and above or as specified in bill of quantities. Galvanising shall conform to IS 4736. Pipes and fittings shall be jointed with screwed/flanged joints, flanges either screwed or welded complete and jointed with 3mm thick rubber gasket as per requirements complete with nuts, bolts and washers etc.

8.2 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 as specified in bill of quantities or elsewhere or as per approval of Engineer-in-charge.

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

8.4 Suction strainer or foot valves shall be C.I., confirming to I.S:4038 - 1979, as specified in bill of quantities.

8.5 Joints

All pipes and fittings shall be provided with flanged joints, with flanges either screwed or welded complete and jointed with 1.5mm thick gasket complete with nuts, bolts and washers etc. Welded joints shall not be permitted for domestic water supply pumping systems or wherever potable water quality is required.

9. **PIPING INSTALLATION**

9.1 Clamps

G.I. pipes shall be supported by G.I. clamps of design approved by Engineer-in-charge. Pipes in wall chases shall be anchored by iron hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from M.S. structural works.

9.2 Unions

Contractor shall provide adequate number of unions on all pipes to enable easy dismantling later when required. Unions shall be provided near each gunmetal valve, stop cock, or check valve and on straight runs as necessary at appropriate locations as required and / or directed by Engineer-in-charge.

9.3 Flanges

The M.S flanges shall confirm to I.S:6392-1971 and shall be galvanized. Flanged connections shall be provided on pipes as required, 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 3mm thick insertion rubber washer. Bolt hole dia for flanges shall conform to match the specification.

9.4 Piping layout shall take due care for expansion and contraction in pipes.

9.5 All pipes using screwed fittings shall be accurately cut to the required sizes. Care shall be taken to remove burr from the end of the pipe after cutting by a round file. Genuine red lead with grumet and a few strands of fine hemp shall be applied and threaded in accordance with IS: 554. Open ends of the piping shall be locked as the pipe is installed to avoid entrance of foreign matter. Wherever reducers are to be made in horizontal runs, eccentric reducers shall be used if the piping is to drain freely, in other locations, concentric reducers may be used.
9.6 Contractor shall provide suitable cement concrete, anchor blocks of adequate dimensions as per spacing mentioned above & at all bends, tee connection and other places required and necessary for overcoming pressure thrusts in pipes wherever pipes are installed on-ground / underground. Anchor blocks shall be of cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size).

9.7 Drain shall be provided at all low points in the piping system and shall be of the following sizes:

<table>
<thead>
<tr>
<th>Mains Drains</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 300mm dia</td>
<td>25mm dia</td>
</tr>
<tr>
<td>Over 300mm dia</td>
<td>40mm dia</td>
</tr>
</tbody>
</table>

Drains shall be provided with forged brass ball valve of equal size. Drains shall be piped through equal size G.I. pipe to the nearest drain or floor waste or as shown on the drawings. Piping shall be pitched towards drain points.

9.8 Vibration Elimination

Piping installation shall be carried out with vibration elimination fittings wherever required.

9.9 Testing

All piping shall be tested to hydrostatic test pressure of minimum 10 kg/cm² or 1.5 times the design pressure whichever is higher for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the Engineer-in-charge.

9.10 Painting

i) After the piping has been installed, tested and run for at least ten days. The piping shall be given two finish coats, 3 mils each of approved color.

ii) The direction of flow of fluid in the pipes shall be visibly marked in white arrows or as directed by the Engineer-in-charge.

5. VALVES & ACCESSORIES

10.1 Sluice / Gate Valves

Sluice Valves above 65 mm (inside screw and non raising screw type) shall be of Cast Iron body and Gunmetal seat with double flanged ends and valve wheel. They shall conform to type PN 1.6 of IS:780. Sluice valves upto 65mm (outside screw raising spindle type) shall be of Gunmetal Full way Valve with wheel tested to 20 Kg./cm² class-II as per I.S: 778 with female screwed ends. Valve wheels shall be of right hand type and have an arrow head engraved or cast thereon showing the
direction for turning open and close.

10.2 **Butterfly Valves**

10.2.1 The Butterfly Valve shall be suitable for waterworks. The Valves conforming to IS: 13095 shall be provided. All valves shall be suitable to withstand the pressure in the system and rating shall be PN 1.6. All valves shall be right handed (i.e. handle or key shall be rotated clock wise to close the valve).

10.2.2 The direction of opening and closing shall be marked and an open / shut indicator fitted.

10.2.3 The material of valves shall be as under:-

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Body</td>
<td>Cast iron</td>
</tr>
<tr>
<td>Disc</td>
<td>Ductile Iron</td>
</tr>
<tr>
<td>Seat</td>
<td>EPDM/ Nitrile rubber</td>
</tr>
<tr>
<td>Shaft</td>
<td>Stainless Steel</td>
</tr>
</tbody>
</table>

10.2.4 The Valve shall be fitted between two flanges on either side of pipe flanges. The Valve edge rubber shall be projected outside such that they are wedged within the pipe flanges to prevent leakages.

10.3 **Non-Return Valve**

Non-return valves shall be of Cast Iron body and Stainless Steel seat. They shall conform to API-594 and have companion flanges. They shall be Dual Plate Type suitable for both horizontal and vertical installation. An arrow mark in the direction of flow shall be marked on the body of the valve.

10.4 **Air Release Valve**

Air valves shall be provided at all high points in the piping system for air vent of the double float type, with G.M. body, vulcanite balls, rubber sealing, etc. Air valves shall be of the sizes specified and shall be associated with an equal size forged ball valve.

10.5 **Ball Valve**

10.5.1 The Ball Valve shall be made from forged brass and tested to 20 Kg/cm² pressure. The valve shall be internally threaded to receive pipe connections.

10.5.2 The Ball shall be made from brass and machined to perfect round shape and subsequently chrome plated. The seat of the valve body bonnet gasket and gland packing shall be of Teflon.

10.5.3 The handle shall be of chrome plated steel with PVC jacket. The handle shall also indicate the direction of ‘open’ and ‘closed’ situations. The gap between the ball and the Teflon packing shall be sealed to prevent water seeping upto 14 Kg / cm².
10.5.4 The handle shall also be provided with a lug to keep the movement of the ball valve within 90 degree.

10.6 **Strainer**
Strainers shall be preferably of the approved type with fabricated steel bodies designed to the test pressure of 10 Kg/cm². Strainers shall be fabricated by minimum 1.2 mm thick stainless steel sheet with 3 mm dia. perforation holes. Strainers shall be provided with flanges or threaded sockets as required. They shall be designed so as to enable blowing out accumulated dirt and facilitate removal and replacement of screen without disconnection of the main pipe.

10.7 **Pressure Gauges**
Pressure gauges shall be of 150mm dia. dial and of appropriate range and be complete with shut off gauge valve etc. duly calibrated before installation. Care shall be taken to protect pressure gauges during pressure testing.

10.8 **Flexible Connection for Pumps**
All suction and delivery lines shall be provided with double flanged reinforced neoprene / Stainless Steel flexible pipe connectors. Connectors should be suitable for a working pressure of each pump. Length of the connector shall be as per specified or as per manufacturer’s details.

11. **ELECTRICAL CONTROL PANELS**

11.1 **Motor Control System**
The main switchboard shall be floor mounted, free standing, cubical type, compartmentalized and shall be factory built fabricated by one of the approved switch board manufacturer. The board shall be fabricated from 2mm thick CRCA sheet and powder coated after seven tank process. The board shall be fabricated with IP 54 degree of protection suitable for operation of 415 volt ± 10% , 3 phase,4 wire,50Hz, AC supply. The switch board shall have provision for termination of cables from top as well as bottom with suitable knockouts. The layout shall be designed for convenient connections and inter-connections with various switchgears. Connections from individual compartments to cable alleys shall be such as not to shut down healthy circuits in the event of maintenance work becoming necessary on a defective circuit. A base channel of 75mm ⧫ 5mm thick shall be provided at the bottom. A maximum of 200mm space between the floor and bottom most panel of unit shall be provided. The bus bar shall be of aluminium complete with heat shrinkable PVC sleeves. The fabrication of switch board shall be taken up only after the drawings for the fabrication of the same are approved by the Engineer –in – charge.

Control panel shall contain starters and safety protection for different types of pump pressure.
motors & various feeders along with its controls. It shall also house the switchgears for incoming as well for outgoings supply. Provision of voltmeter (for incomer) & ammeter for incomer as well as for other feeders with selector switch, a set of LED indicating light for incoming phases as well as status indication of each equipment as per the schedule of quantities. The voltmeter & indication lamps shall be protected by MCBs.

The feeders for all those motors having more than 7.5 HP capacity shall be provided with fully automatic Star Delta starters with motor duty MCCBs for short circuit protection only (ICS = 100% ICU) & Overload Relays with contactors of suitable range & ratings, for overload protection, while less than or equal to 7.5 HP motor shall have Motor protection circuit breaker (MPCB) with over load & short circuit protection of suitable rating. Single phase preventers shall be provided for all 3 phase motors. Single phase preventer shall be in conformity with relevant ISI standards. Single phase preventer shall act when the supply voltage drops down to 90% of the rated voltage or failure of one or more phases. Single phase preventer shall be voltage operated and of approved make.

Other feeders of the panel which don’t require starter, shall be housed with:

i) MCCB with Thermal magnetic release & should provide adjustable setting for overload and short circuit protection with ICS = 100% ICU.

ii) MCB used for controlling shall be with tripping characteristics of C curve. The miniature circuit breakers shall be 1/2/3/4 pole as per requirement. The breaking capacity of MCBs shall have minimum 10KA.

ON-OFF switches for each motor / equipment should not be provided on the cover of the control panel. But at the same time interlocking shall be provided between switch and the door in such a way that the door of the panel cannot be opened when the supply is ON.

The panel shall be provided all identification tags, danger board etc as per IS standard.

All control panels shall be provided with detailed control circuit diagram indicating the terminal numbers and color coding of the wires used in the panels. This diagram shall be pasted on the inner side of the cover and protected with PVC transparent lamination.

All MCCBs / MPCB’s shall be equipped with extended front operated rotary handles on the doors. Rotary handle should have provision for pad lock.

Outgoing from each of the MCCB shall be extended to the cable alley by providing necessary busbar of suitable rating and supports etc. for terminating the outgoing feeders.

The detailed specification of switch gears and other accessories shall follow as described in Package A of these tender specifications.
12. **PUMP MOTOR CONTROLLER CUM WATER LEVEL INDICATING PANEL & SYSTEM**

12.1 **Water Level Indicators and Controllers**

The hydrostatic pressure sensor (Water level indicator) shall operate on hydrostatic pressure measurement principle. The sensors shall be made of Stainless Steel for installation in storage tanks, and capable of providing 4 to 20 mA analog signal compatible with PLC signal inputs and all control outputs to MCC panel (Plumbing/Water supply), for various water tanks as per the schedule of quantities. The Pressure Transducers shall be used for water level measurement, and it shall be convenient to mount on the water tanks. Hydrostatic pressure level sensors shall be submersible or externally mounted pressure sensors suitable for measuring the level of liquids in deep tanks or water in reservoirs. Level measurement shall be based on the pressure measurement principal, also referred to as hydrostatic tank gauging (HTG). It shall work on the principle that the difference between the two pressures (d/p) is equal to the height of the liquid (h, in inches) multiplied by the specific gravity (SG) of the fluid. Following shall be the formula used for measurements / calibration: \( \frac{d}{p} = h(SG) \). These sensors sense increasing pressure with depth and because depth is proportional to Volume for a regular tank, the Volume of Water can be easily calculated using a PLC.

12.2 **Level Indicator / Controller Panel**

The Centralized PLC control panel shall be front operated, cubicle construction, wall mounted type, fabricated out of 1.6 mm thick CRCA Sheet, with hinged lockable doors, dust and vermin proof, powder coated of approved shade, inter-connections, having, internal wiring, earth terminals, Top / Bottom control cable entry, numberings etc. comprises of touch-screen display board (Minimum Diagonal size 8") along with all accessories for complete Programmable logical controls & indications, having necessary interlocks, Inputs/Outputs, required number of repeater amplifiers, all audio-visual alarms as per the requirements listed below i/c emergency stop push button on the panel etc. The panel shall have BMS compatible with open protocol.

13. **CABLES**

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

13.2 Cables shall conform to I.S: 1554 and carry ISI mark.

13.3 Wiring cables shall conform to I.S 694.

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

13.5 All control cables shall be copper conductor PVC insulated armored and PVC sheathed 1100 Volt grade.

13.6 All cables shall have stranded conductors. The cables shall be in drums as far as possible and bear manufacturer’s name.
13.7 All cable joints shall be made in approved manner as per standard practice.

14. **CABLE TRAYS**

14.1 Contractor shall provide M.S slotted cable trays at locations as shown on the drawings and of sizes as given in the bill of quantities.

14.2 Cable trays shall be supported from the bottom of the slab at intervals of 60cms at both ends by anchor fasteners. Cost of MS angle, rods and anchor fasteners etc. shall be included in the rate of the tray and no separate payment shall be made on this account.

14.3 Cost of clips, bolts, nuts, support rods and any other materials required to fix the trays in proper manner shall be included in the rate for trays.

15. **EARTHING**

15.1 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/armour 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 sweateted.

15.2 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.

15.3 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.

16. **CONTROL PANELS / STARTERS**

16.1 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:- (Switch gear as given in the bill of quantities).

a) Incoming main isolation MCCB of required capacity.

b) Fully Aluminum taped Bush Bar of required capacity.
c) Isolation MCCB one for each motor.

d) 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 upto 7.5 HP and Star Delta from more than 7.5 H.P)

e) Single phase preventor of appropriate rating for each motor.

f) Panel type ampere meters one for each motor with selector switch.

g) Panel type voltmeter on incoming main with rotary selector switch to read voltage between phase to neutral and phase-to-phase.

h) Neon phase indicating lamps for incoming main and on/off indicating lamps for each motor.

i) Rotary switch for manual or auto operation for each pump (manual/auto off).

j) Fully taped separate aluminum bus bars of required capacity and with required outlets.

k) Space for liquid level controllers as specified + 1 extra space.

l) 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.

m) Provision of main incoming cables from the top of the panel.

16.2 All switch gears and accessories shall be of approved make such as “Siemens, English Electric, Larson & Toubro” or equivalent, or as specified.

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

17. **MEASUREMENTS**

17.1 Raw water, re-lift and sump pumps and swimming pool pumps shall be measured by numbers / sets and shall include all items as given in the bill of quantities.

17.2 Motor control panel and level controllers shall be measured by numbers.

17.3 Pipes for suction and delivery header and mains shall be measured per linear meter along the centre line of the pipe and shall be inclusive of all fittings.
17.4 Cable trays and cables shall be measured per linear meter.
17.5 Structural clamps including hangers shall be measured by weight calculated from sections used. No separate payment shall be admissible for bolts, anchor bolts, rawl plugs etc.

17.6 No separate payment shall be made for making connections of the existing service lines to the pumps. Vibration eliminator pads are included in the scope of this work.

18. **GUARANTEE**

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

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

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

18.4 The warranty shall expressly include replacement of all defective or under capacity equipment, Engineer-in-charge may allow repair of certain equipment if the same is found to meet the requirement for efficient functioning of the system.

18.5 The warranty shall include replacement of any equipment found to have capacity lesser than the rated capacity as accepted in the contract. The replacement equipment shall be approved by the Engineer-in-charge.

18.6 The contractor shall include in his rates the operation of all mechanical equipment's for a period of six months from the date of commissioning. No separate payment will be made on this account.

19. **COMMISSIONING**

After successful testing of the different items in parts, the Contractor shall provide all facilities including necessary piping, labour, tools and equipment's etc. for carrying out testing and commissioning of the entire water treatment plant complete as per requirement in the presence of Engineer-In-charge or his representative whenever and as may be required.
CHAPTER- 16
TECHNICAL SPECIFICATIONS- LIFTS WORKS

The scope of work shall cover design, supply delivery, installation, testing and commissioning of passenger lifts/ passenger cum bed lifts/Service lifts. All lifts shall be VVVF operated, gearless, Central opening and with Machine room. The Lifts shall be with facility for duplex/triplex selective/collective operation. Car enclosure finish shall be SS (as per OEM) scratch proof moonrock/honeycomb. SS handrail not less than 600mm long at 900mm above floor level, to be provided inside the lift car as per requirement. Suitable lights and fans as per requirement shall be provided. Lift car size, Lift well size, Lift pit overhead, entrance width, car height etc. shall be as per NBC 2016 or OEM standards. The dimensions of Lift well shown in tender drawings are only indicative and EPC contractor shall provide the same as required by OEM. The scope of work shall also include the following item of civil works.

a) Necessary scaffolding temporary barricade in the hoist way required during the erection of the elevators.
b) Minor building work comprising of cutting holes and making good the car and counterweight rail brackets, hall buttons and indicators including laying of sills in position.
c) Steel items such as machine beams, bearing plates buffer support channels, sill angles and fascia plates etc.
d) Suitable trap doors with steel chequered plate covers.
e) Providing and install a suitable vertical iron ladder for access to the pit.
f) Any other item required for successful completion and commissioning of lifts. (including the hoisting beam in the machine room)

The work shall be done in accordance with regulations of any local code and following ISI codes which govern the requirements of installations.

- Indian Electricity Act 1910.
- Indian Electricity Rules, 1956.

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. Variable voltage variable frequency drive system (with close loop) shall be used.

SHOP DRAWINGS AND APPROVAL OF ELECTRICAL INSTALLATIONS:
The selected tenderer shall prepare a furnish shop drawings for approval by The Client, such shop drawings shall be based on the Architectural drawings and requirements laid down in specifications, local laws and regulations etc.

The detailed drawings shall be submitted within one month of placement of order. The successful tenderer shall obtain the approval of electrical Inspector and other local authorities as per requirements before submitting the drawings to Client/Engineer. The contractor shall not proceed with in installation work till the drawings are approved by the Engineer-in-Charge.

Approval of contractor's drawings shall not absolve the contractor of any of his obligations to meet the requirements of specification under this contract. Five sets of completion drawings operation manual, maintenance manual, spare parts details shall be submitted to the Client/Engineer after completion of work.

GUARANTEE

The contractor shall guarantee the equipment against all defects of materials and workmanship for a period of one year from the date of Handing over of the equipment as certified by the owner. Any defects arising during the guarantee period shall be rectified and replaced by the tenderer, at his own expense, to the satisfaction of the owner.

PERMITS, INSPECTION & LICENSE FEE

The contractor shall arrange all necessary local, provincial or national government permit and shall make arrangements for inspection and tests required thereby. Expenses to be borne by contractor.

POWER SUPPLY

The apparatus shall be designed to operate on 415 + 10% - 20% Volts, 3 Phase, 4 wires, 50 Hz A.C. Supply for illumination signal equipment shall be 240 Volts single phase 50Hz A.C.

ELECTRICAL WIRING

The necessary A.C. supply of 3 Phase, 415 Volts 50 HZ shall be made available in the main control switch unit to be provided by the contractor in the machine room. All the electrical works beyond the main supply switch shall be carried out by the contractor i.e. supply and installations of panels for drive motors, switches and control complete with wiring as per system requirement and approval of the Engineer.
The wiring shall be carried out strictly in accordance with Indian Electricity Rules and Indian code of Practice for Electrical Wiring Installation IS-732-1963 System Voltage not exceeding 650 V).

The cable and conduits to be used shall be of suitable size and grade conforming to relevant IS specification. Wiring for LT switchboard to the motor terminal shall be with heavy duty 1.1 KV grade XLPE insulated PVC sheathed, FRLS aluminium cable. All the trailing cables used for control and safety device shall conform to IS: 4289-1967, Specifications for lifts cables. The trailing cable circuits for controls, safety devices, lighting and signaling shall be separate and distinct.

Power wiring between controller and main board to various landings shall be drawn in suitable size heavy gauge conduit stove enameled/painted conforming to IS specifications.

The Voltage and frequency of the supply shall be subjected to variations permissible under Indian Electricity Acts and Rules.

CAR FRAME:

The car frame, which supports the car platform and enclosures, shall be made of structural steel and equipped with suitable guides and a car safety device mounted underneath the car platform. The hoist ropes shall include adjustable self-aligning hinges. The car shall be so mounted on the frame that vibration and noise transmitted to the passenger is minimized.

CAR SAFETY AND GOVERNER:

Suitable car safety to stop the car whenever excessive descending speed is attained shall be operated by a centrifugal speed governor connected to the governor through a continuous steel rope.

The governor shall be provided with self tensioning device to keep governor rope in proper tension even after rope stretch. Suitable means shall be supplied to cut off power from the motor and apply the brake on application of the safety.

COUNTER BALANCE:

A Suitable guided structural steel frame with appropriate filler weights of cast iron shall be furnished to promote smooth and economic operation.

TERMINAL AND FINAL LIMITS:

Terminal limit switches shall be provided to slow down and stop the car automatically at the terminal landings within permissible over travel and final limit switches shall be provided to automatically cut off the power and apply the brake,
should the car travel beyond the permissible over travel. They shall act independently of the operating devices and buffers.

**TERMINAL BUFFERS:**

Heavy duty spring buffers shall be installed as a means of stopping the car and counterweight at the extreme limits of travel. Buffers in the pit shall be mounted on steel channels which shall extend between both the car and counterweight rails.

**CONTROLLER:**

A Controller shall be provided to control starting stopping and speed of the elevator motor and also be automatically able to apply the brake if any of the safety devices operate or if power fails from any cause. In case of power failure and again restore of power the lift shall land to next floor and shall not go to basement/lowest level. Suitable software/hardware or rescue device shall be provided.

**REVERSE PHASE RELAY:**

A reverse phase relay shall be provided on the controller which is designed to protect the lift equipment against phase reversal and phase failure.

**GUIDES:**

Machined steel tee guides shall be furnished for the car and counterweight. The guide rails should be of steel solid and shall have tongued and grooved joints. Sliding clips shall be used for fastening the guides to allow building settlement without distorting the guide rails. To keep down the noise level and to reduce wear and tear of the sections, only Nylon Ribs shall be used in the guide shoes, after smoothening of the rails. The flanges shall be machined for the fish plate mounting such that rail alignment at joints almost remain constant.

**FOUNDATIONS:**

The machine shall be placed directly above the hoist way upon the machine room slab provided by the Owner.

**ROPES:**

The elevator shall be provided with traction steel ropes. Steel wire rope having a tensile strength of not less that 12.5 Ton/cm² of good flexibility shall be used for lift. The lift rope shall conform to IS: 14665 – (Part-4- Sec-8):2001.

**MACHINE:**

The machine shall be gearless type.

**BRAKE:**
The direct current brake shall be spring applied and electrically released and designed to provide smooth stop under variable loads. The brake should be capable of operation automatically by various safety devices, current failure, and by normal stopping of car. It should be possible to release the brake manually, such as by various safety devices, current failure, and by normal stopping of car. It should also be possible to release the brake manually, such as requiring the permanent application of manual force so as to move the lift car in short sties. For this purpose one set of brake release equipment shall be supplied.

**MOTOR:**

The motor shall be suited to the service proposed and arranged for adequate lubrication. The motor shall be class F insulation and one (1) hour rated squirrel cage induction type having high starting torque. It shall also be provided with Thermisters embedded in the stator windings for the highest degree of thermal motor protection.

**CONTROL**

The control shall be variable voltage variable frequency A.C. variable voltage, closed loop control system using solid state devices and electronic speed pattern generator to command the motor from a velocity transducer and load compensation circuits for a comfortable ride.

In Normal operation, the electromagnetic brake shall only be applied when the lift has come to a complete standstill. The brake shall only be meant for holding the lift in position at every landing, providing stopping without any jerking effect. Each controller cabinet containing memory equipment shall be properly shielded from the pollution.

**MICROPROCESSOR**

The control shall employ a microprocessor working on a program such that precision leveling and highly efficient handling of passengers for least possible waiting and reduced travel time is ensured. The microprocessor system should be designed to accept programming with minimum downtime. It should be able to monitor the state of input calls (such as car calls from COP and hall calls from hall fixtures) and output commands such as starting, decelerating and stopping the elevator. It should be able to generate floor location data, thereby, providing a reference position to establish the safety zones for door opening and closing, and also to initiate leveling slowdown.

**DUPLEX COLLECTIVE OPERATION**

The operation shall be duplex collective with/without attendant for each elevator and shall consist of the following:

**IN THE CAR**

There shall be furnished a flush type attractively finished stainless steel panel which contains a series of luminous buttons numbered to correspond to the
landings served, an emergency stop switch and an emergency call button connected to a bell which serves as an emergency signal.

**AT HOISTWAY LANDINGS**

There shall be provided an UP luminous push button and a DOWN luminous push button at each intermediate landing and a single button at the terminal landings. The car shall not start unless the door is in the closed position and all hoistway doors are closed in the locked position.

If the car is idle and one or more car or landing buttons above the landing at which the car is standing are pressed, the car shall start in the UP direction and proceed to the highest landing for which any button is pressed and stops at intermediate landing for which a car button or up landing button is pressed sufficiently in advance of the car's arrival at such landings to permit these stops to be made. After each stop, the car shall proceed in the UP direction until it reaches the highest landing for which a call is registered. The car shall not stop on the UP trip at any landing in response to a DOWN call.

Similarly, if the car is idle and one or more car or landing buttons below the landing at which the car is standing are pressed, the car shall start in the DOWN direction, proceed to the lowest landing for which any button is pressed and stop at each intermediate landing for which a car button is pressed.

When the car is idle and a button for a landing above the car and a landing below the car are pressed, the car shall start towards the landing corresponding to the button pressed first. The call registered for the landing in the opposite direction from the car shall be answered after the car has responded to the farthest call in the direction established by the button pressed first.

A time relay shall hold the car for an adjustable interval of few seconds at the landings at which stops are made to enable passengers to enter or leave the car.

**Lift Voice Announcement:**

The lift shall be provided with floor announcement system with volume control.

**Lift instructions:**

Steel plate containing following instructions shall be provided inside each lift car:

i. Lift number __

ii. Capacity _____Kg, ______persons.

iii. Any other instruction as per manufacturer's standard or other relevant codes.

Steel plate containing following instructions shall be provided outside each lift car, on all floors:

i. Lift number ____
ii. Capacity _____Kg, _____persons.

iii. Any other instruction as per manufacturer's standard or other relevant codes.

Other Details

a. Work shall be carried out as per CPWD specifications unless otherwise specified.

b. Suitable scaffolding in the hoist way, cutting work and all minor civil works, if any, required shall be done by contractor without any extra cost.

d. All steel items in machine room, hoist way and lifting arrangement in the lift machine room shall be provided by the contractor without any extra cost.

e. At the time of erection, testing & commissioning of lift works all the landing door openings shall be suitably protected by the contractor to avoid any miss happening.

f. All exposed metal parts will be painted with good quality anticorrosive low VOC paint after erection and before commissioning of the lift.

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

CAR DOOR/LANDING DOOR

The car entrance shall be provided with stainless steel centre opening doors in moon rock finish or as per direction of Engineer In Charge. The lift car door shall have a fire resistance rating of two hours.

HOISTWAY DOORS:

At each landing, a center/ telescopic opening, stainless steel sliding door in plain finish giving a clear opening as per CPWD general specifications for electrical works – Part-III – Lifts & Escalators, shall be provided.

SIGNAL AND OPERATIVE FIXTURES:

The following signal and operative fixtures shall be provided for each lift in stainless steel face plates except in fireman's switch which shall have a glass face plate.

a) CAR OPERATING PANEL

There shall be one (1) No. panel in car, with hinged stainless steel face plate and shall comprise illuminated floor buttons, door open and emergency stop controls emergency call buttons, door open and emergency stop controls emergency call button, two position key operated switch, a Buzzer, UP and DOWN direction light panels, a non stop button, and an integral interphone. The jewels and accentuator shall be of modular construction, face plate mounted, rewired using snap on lugs.

b) HALL BUTTONS AND HALL POSITION INDICATOR

There shall be provided combined signal fixture (one riser) of compact design and of attractive hairline stainless steel face plate at the elevator entrance on each
floor which for terminal landings shall have a single luminous push button and for intermediate landings shall have an UP luminous push button and a DOWN luminous push button. The jewels shall be of modular construction mounted on a stainless steel face plate. Whenever a button is pressed, the jewel shall light up to indicate registration of the call and shall remain enlightened till the car arrives.

c) **CAR POSITION INDICATOR IN CAR**

This shall be of compact design and of attractive hairline finish stainless steel face plate with easy to read digital display of the floors, indicating through which floor the elevator is passing or on which floor the elevator is stopped. This shall also incorporate illuminated arrows showing the direction of travel.

d) **BATTERY OPERATED ALARM BELL AND EMERGENCY LIGHT**

A solid state siren type alarm unit operated by 2 Nos. 9 volt rechargeable Nickel Cadmium batteries shall be provided which shall give a waxing and waning siren when alarm bell in the car is pressed momentarily.

An emergency light unit using a 9 volt dry battery power pack and incandescent lamp with stainless steel face plate shall be provided inside the car which shall operate automatically in the case of power failure.

e) **OVERLOAD WARNING**

Overload warning radars with audio-visual indication (visual indication shall show OVERLOADED) with stainless steel face plate shall be installed in the elevator car, so that when there is overload in the car the sign shall light up a flash indicating OVERLOADED and a buzzer shall operate during this period and the doors shall remain open unit the overload is removed.

f) **FIREMAN’S SWITCH**

A toggle switch covered by a glass cover shall be provided on the ground floor for each elevator which shall permit a fireman to call the elevator to the ground floor by canceling all car and landing calls. The elevator shall then stop at the ground floor with the door open to permit the fireman to have exclusive use of the elevator without any interference from the landing calls.

g) **INTERPHONE**

Interphone shall have one master unit in each machine room, one master unit on the ground floor for each 1 (outside hoist way) and one slave unit in each elevator car.

**ELECTRIC DOOR OPERATOR FOR CAR DOOR AND HOISTWAY DOOR:**

An electric door operator for opening and closing the car door shall be provided. The opening of a car and hoist way doors shall be such that the doors shall start opening meant for so that by the time the elevator stops completely, the elevator and hoist way doors shall be fully open.
The equipment shall consist of a machine on the elevator car operating the car door when the car is stopping at a landing.

The car door and hoist way door shall be mechanically connected and shall move simultaneously in opening and closing.

The car and hoist way doors shall be power opened and closed and shall be checked in opening and closing with an oil cushioning mechanism built into the gear unit.

Each hoist way door shall be provided with an interlock which will prevent movement of the car away from the landing unit.

The doors are closed in the closed position as defined in the ISI codes.

An electric contact for the car door shall be provided which shall prevent car movement from the landing unless the door is in the closed position as defined in the ISI codes. The locking arrangement shall be so designed that the electrical circuit cannot be completed unless the doors are in the closed position and mechanical latching is effected.

Necessary switches shall be provided in the elevator machine room to control the operation of the doors.

The car and hoist way, doors shall open automatically as the car is stopping at a landing. The closing of the car and hoist way door must occur before the car can be started. Doors can be stopped and reversed during their closing motion.

**DOOR HANGER AND TRACKS :**

For the car and each landing door, sheave type two point suspension hangers complete with tracks shall be provided. Means shall be provided to prevent the door from jumping off the track and for vertical and literal adjustment of doors.

Sheaves and rollers shall be of steel and shall include shielded ball bearing to retain grease lubrication. Adjustable ball bearings rollers shall be provided to take the upward thrust of the doors. Tracks shall be of suitable steel section with smooth surface. The locking of the two leaf parting type doors should be positive.

**SAFETY SENSOR :**

A safety sensor(one on each door panel) shall extend to the full height of the car door.

**LANDING ENTRANCE MATERIAL'S :**

These shall consist of headers, extruded aluminium sills and strut angles.

**WIRING :**

Complete wiring in the equipment room from controller to various landings shall be done in heavy gauge conduit / metal duct & shall confirm to IE rules 1956 . DC power & AC power shall not run in same conduit / duct and they shall be laid as per IE rules.
AUTOMATIC RESCUE DEVICE:

Automatic Rescue Device to be provided for all the lifts with battery backup so that it can land to the nearest level in case of power failure. Automatic Rescue Device shall have suitable battery backup so that it can operate minimum seven times in a day provided the duration between usage is at least 30 minutes.

TESTING OF LIFTS

The contractor after the installation of the lifts has to conduct the following test and furnish the readings to ascertain the performance of the lifts.

1. Levelling Test
2. Safety Gear Test
3. Contract Speed Test
4. Lift Balance
5. Car and Landing Interlock Test
6. Controllers Test
7. Normal Terminal Stopping Switches
8. Final Terminal Stopping Switches
9. Insulation Resistance Test
10. Ropes
11. Buffer Test
12. Earthing
13. Performance Test

List of IS codes for Lift installations applicable is given below:

1. Code of Practice for installation, operation and Maintenance of electric passenger & goods lifts. IS-1860
2. Code of Practice for installation, operation and Maintenance of electric service lift. IS-6620
3. Specification for electric passenger & goods lifts IS-4666
4. Electric service lift. IS-6383
5. Online dimension for electric lifts IS-3534
6. Code of practice for installation and maintenance IS-4591
7. Specification for steel wire suspension ropes for lifts & hoists. IS-2365
8. Glossary of terms relating to wire ropes IS-2363
9. Specification for lifts cables IS-4289
10. Glossary of terms for electrical cables & conduits IS-1591
11. Specification for rubber insulated cables IS-434/1
12. Specification for varnished, cotton cloths & tape for electrical IS-3352
13. Specification for lift door locking devices and contracts IS-7759
14. Specification for hot rolled and slit steel bars IS-1173
15. Method of loading rating of worm gear IS-7443
   and helical gear box
17. Isometrics screw threads IS-4218
18. Degree for protection provided by enclosure for low voltage Switchgear and control gear
   19. Specification for HRC cartridge fuse links upto 650 volts. IS-2208
   20. Code of practice for electrical wiring installation IS-732
       (System voltage not exceeding 650 volts).
   21. Voltage & frequency for AC transmission & distribution system IS-5850
   22. Specification for AC contractors voltage not exceeding 1000V IS-2959
   23. Heavy duty air break switched & composite unit of air break switches and fuses IS-4047
       For voltage not exceeding 1000 volts.
   24. General requirements for switch gear & controller for voltage IS-4237
       Not exceeding 1000 volts.
   25. Specification for motor starter of voltage up to 650 V IS-1822
   26. Nomenclature of floors & storeys IS-2332
   27. Code of practice for sound insulation of non-industrial building IS-1950
   28. Code of practice for installation & maintenance of inducting motors IS-906
   29. Specification for three phase induction motor IS-235
   30. Guide for testing three induction motor IS-4029
   31. Specification for degree of protection provided by enclosure IS-4691
       for rotating electrical machinery
   32. Designation of method of cooling for rotating electrical machines IS-6362
   33. Classification of insulating materials for electrical machinery and IS-1271
       Apparatus in relation to their thermal stability in service.
   34. Code of practice for earthing IS-3043
   35. Electrical installation fire safety of building IS-1646
   36. Code of practice for the protection of buildings and allied IS-2309
       Structures against lighting
   37. Specification for hoist way door locks IS-7754
   38. Rules for the design, installation, testing and operation of the IS-1735
       lifts, escalator and moving parts
CHAPTER- 17

TECHNICAL SPECIFICATIONS FOR GAS & VACUUM & PIPING SYSTEM

1. General
The following technical specifications shall be read in conjunction with Specific Conditions of Contract and General Conditions of Contract. If there are any provisions in these Technical Specifications, which are at variance with the provisions in the above mentioned documents, the provisions in these Technical Specifications shall take precedence.

a. General Scope of Work:
The scope of proposed work consists of providing Gas and Vacuum Piping System for the State of Art Laboratory Building for Indian Pharmacopoeia Commission at Raj Nagar, Ghaziabad, Uttar Pradesh. The Scope of Work includes Supply, Installation, Testing & Commissioning of:
- Gas Piping System
- Vacuum Piping System
The work shall, in general, conform to the technical specification detailed hereunder. Wherever any aspect of design / construction / material standards is not covered under the above mentioned specification, relevant standards shall be referred to in the order of precedence which shall be as follows. In the case of discrepancy between the Schedule of Quantities, the Specifications and /or the Drawings, the following order of preference shall be observed –
- Description of Schedule of Quantities
- Drawings
- Technical Specifications
- Indian Standard Specifications of BIS/ NBC/ IRC/ BS/ ASTM/ DIN
- For items not covered by any of the above, the work shall be done, as per sound engineering practices and as directed by the Engineer-in-charge.

GAS PIPING SYSTEM

1. INTRODUCTION:
In the State-of-Art Laboratory Building for Indian Pharmacopoeia Commission at Raj Nagar, Ghaziabad, Uttar Pradesh, there is requirement to create R & D Laboratory facility. The Laboratory facilities shall meet the Good Laboratory Practices (GLP) and safety requirements.

2. SCOPE
The contractor shall carry out:
- Design of Zero (Instrument) Air Piping.
- Design of Nitrogen Piping.
- Design of Mix Gas Piping.
- Design of Hydrogen Piping
• Design of Acetylene Piping
• Design of LPG Piping
• Design of Helium Piping

The scope of work shall cover supply, storage at site, transportation to the place of erection, fabrication/assembly, laying/erection, painting, testing, commissioning and handing over of the industrial tubing & piping system for various Gases for the project as a whole with necessary supports, clamps and supporting structures. The erection work shall be carried out as per the Shop Drawings to be prepared by the contractor and approved by the Engineer-In-Charge.

The tender drawings are only indicative and meant to portray the scope and quantum of works involved at site. The Contractor shall himself assess the works requirement and prepare shop drawings for actual execution at site. 2 Sets of Shop Drawings shall be prepared by the contractor and submitted to Engineer-In-Charge for approval. The observations/suggestions, if any provided by Engineer-In-Charge shall be incorporated in drawings. Shop drawings shall be re-submitted for approval of Engineer-In-Charge before commencement of works at site.

3. DESIGN CRITERIA:

3.1. Zero Air:
• Laboratory has Instrument Air requirement.
• Instrument Air shall be drawn from Zero Air Gas Bank and supplied to various user points as per approved shop drawings.
• The supply of Instrument Air will be safely, suitably regulated and provided to various user points through main header piping system as per approved shop drawings.
• MOC of pipes and fittings shall be SS 316 (ASTM A-269).
• All joint of pipes & valves shall be socket welded, except user point 15 NB dia valves, filter and pressure regulator (screwed end).
• Instrument Air shall consist of single filter and pressure Regulator at the inlet of Lab. There is no addition regulator required in lab of room wise/ user point wise.
• Tapping for user points inside the laboratory with individual 1/2” & 1/4” OD tapping from main header shall be done. Branch wise or user point tapping shall have an isolation valves or bench mounted valves.
• Existing instrument line pressure is 6 Bar. Hence pressure testing for the lines shall be 9 bar.

3.2. Nitrogen - PSA:
• Laboratory has Nitrogen requirement.
• Nitrogen gas shall be drawn from Nitrogen Gas Bank and supplied to various user points as per approved shop drawings.
• The supply of Instrument Air will be safely, suitably regulated and provided to various user points through main header piping system as per approved shop drawings.
• MOC of pipes and fittings shall be SS 316 (ASTM A-269).
• All joint of pipes & valves shall be socket weld, except user point 15 NB dia valves, filter and pressure regulator (screwed end).
• N2 line shall consist of single filter and Pressure Regulator at the inlet of lab. There is no addition regulator required in lab of room wise/ user point wise.
• Tapping for user points at inside the laboratory shall be with individual 1/2” & 1/4” OD tapping from main header. Branch wise or user point tapping shall have an isolation valves or bench mounted valves.

3.3. Mixed Gas (CO₂ + N₂):
• Laboratory has Mixed Gas requirement.
• Mixed Gas shall be drawn from Mixed Gas Bank and supplied to various user points as per approved shop drawings.
• The supply of Mixed Gas will be safely, suitably regulated and provided to various user points through main header piping system as per approved shop drawings.
• MOC of pipes and fittings shall be SS 316 (ASTM A-269).
• All joint of pipes & valves shall be socket weld, except user point 15NB dia valves, filter and pressure regulator (screwed end).
• Tapping for user points at inside the laboratory shall be with individual 1/2” & 1/4” OD tapping from main header. Branch wise or user point tapping shall have an isolation valves or bench mounted valves.

3.4. Hydrogen:
• Laboratory has Hydrogen Gas requirement.
• Hydrogen Gas shall be drawn from Hydrogen Gas Bank and supplied to various user points as per approved shop drawings.
  • The supply of Hydrogen Gas will be safely, suitably regulated and provided to various user points through main header piping system as per approved shop drawings.
  • MOC of pipes and fittings shall be SS 316 (ASTM A-269).
• All joint of pipes & valves shall be socket weld, except user point 15NB dia valves, filter and pressure regulator (screwed end).
• Tapping for user points inside the laboratory shall be with individual 1/2” & 1/4” OD tapping from main header. Branch wise or user point tapping shall have an isolation valves or bench mounted valves.

3.5. Helium:
• Laboratory has Helium gas requirement.
• Helium Gas shall be drawn from Helium Gas Bank and supplied to various user points as per approved shop drawings.
• The supply of helium Gas will be safely, suitably regulated and provided to required user points through main header piping system as per approved shop drawings.
• MOC of pipes and fittings shall be SS 316 (ASTM A-269).
• All joint of pipes & valves shall be socket welded, except user point 15NB dia valves, filter and pressure regulator (screwed end).
• Tapping for user points inside the laboratory shall be with individual 1/2” & 1/4” OD tapping from main header. Branch wise or user point tapping shall have an isolation valves or bench mounted valves.

3.6. Acetylene:

• Laboratory has Acetylene gas requirement,
• Acetylene Gas shall be drawn from Acetylene Gas Bank and supplied to various user points as per approved shop drawings.
• The supply of Acetylene Gas will be safely, suitably regulated and provided to required user points through main header piping system as per approved shop drawings.
• MOC of pipes and fittings shall be SS 316 (ASTM A-269).
• All joint of pipes & valves shall be socket weld, except user point 15NB dia valves, filter and pressure regulator (screwed end).
• Tapping for user points at inside the laboratory shall be with individual 1/2” & 1/4” OD tapping from main header. Branch wise or user point tapping shall have an isolation valves or bench mounted valves.

3.7. LPG:

• Microbiology Lab has LPG gas requirement.
• LPG Gas shall be drawn from LPG Gas Bank and supplied to various user points as per approved shop drawings.
• The supply of LPG Gas will be safely, suitably regulated and provided to required user points through main header piping system as per approved shop drawings.
• MOC of pipes and fittings shall be SS 316 (ASTM A-269).
• All joint of pipes & valves shall be socket weld, except user point 15NB dia valves, filter and pressure regulator (screwed end).
• Tapping for user points at inside the laboratory shall be with individual 1/2” & 1/4” OD tapping from main header. Branch wise or user point tapping shall have an isolation valves or bench mounted valves.

4. CODES & STANDARDS

All piping works covered under this specification shall comply with currently applicable statutes, regulations and safety codes. They shall comply in all respects with the requirements of the latest editions of the codes and standards. Important relevant IS Codes for this work are as listed below:

4.1. Steel Pipes, Tubes & Fittings - Codes & Standards
• American Society for Testing and Materials (ASTM)
  ➢ A-269 Seamless and Welded Austenitic Stainless Steel Tubing for General Service TP 316
  ➢ A-370 Standard Methods and Definitions for Mechanical Testing of Steel Products
  ➢ A-632 Seamless and Welded Austenitic Stainless Steel Tubing (Small Diameter) for General Service
• American National Standards Institute (ANSI)
  ➢ B31.1 Code for Pressure Piping, Chemical Plant and Petroleum Refinery Piping
  ➢ B31.3 Process Piping
• IS: 1239 – 1990 : M.S. Tubes, Tubular & Part-I other wrought steel fittings.
• IS: 3589 – 2001 : Seamless (or) electrically welded steel pipes for Water, gas & sewage.
• IS: 5504 - 1997 : Spiral welded pipes.
• IS: 1239 (Part-2) : M.S. Tubes, tubular and (1992) wrought Steel fittings
• IS: 11428-1985 : Wrought carbon steel butt (Part 1 to 3)
• American Society of Mechanical Engineers (ASME)
  Section IX Welding Qualification
• Welding Procedure/Qualification: ASME B 31.3/31.8, ASME Sec IX & IS: 817
• ASME Sec IX & IS: 814: Material Specifications, Welding rods, Electrodes & filler wire etc.
• ANSI-B-16.5: Pipe Flanges & Flanged Fittings
• ASME/ANSI-B-16.10: Face-to-Face & End-to-End Dimensions of Valves
• ANSI-B-18.2.1: Square & Hex Bolts & Screw.
• ANSI-B-18.2: Stud & Nuts.
• IS Standard or Equivalent: Gauges

5. TECHNICAL SPECIFICATIONS FOR GAS TUBING WORKS:

5.1. General:
The supply, installation, testing and commissioning of SS Tubes/ Pipes, valves & fittings shall be carried out according to the approved shop drawings, technical specifications, latest engineering practices and instructions of the Engineer-In-Charge. The erection shall be carried out by highly skilled workmen to be deployed by the contractor. The Contractor shall take care of positioning, leveling and laying/joining of all tubing’s and cylinder banks as well as supporting structures within the required accuracy and tolerance limits. It shall be deemed as a contractual obligation that the tubing’s are not thrown out of alignment or lifted off during commissioning and subsequent operation.
There may be more than one contractor working in the area at the same time. As such the work has to be carried out in proper co-ordination and consultation with the Engineer-In-Charge and all other parties concerned with the work. The Contractor shall take due notice of the working conditions, practices and agreements prevalent in the area of the plant site and satisfy himself before quoting.

The Contractor shall take due care to avoid any damage to the existing structures. In case there is any damage to the existing structures because of works being executed by the Contractor, the Contractor shall make good the same at its own cost.

The Contractor shall be responsible for paying strict attention to statutory regulations for prevention of accidents and to other safety rules. The regulations for prevention of accidents shall be displayed at appropriate places and should be distinctly visible to all personnel working in the area.

The Contractor shall supply all required consumables, construction and erection materials, petrol, diesel oil, kerosene, solvents, sealing compounds, tapes, brazing and soldering materials, welding sets, tube bending machines, cables, clamping tools, gauges, erection bolts, nuts and packing sheets/compounds, temporary supports, wooden blocks, spacers, templates, jute and cotton wastes, sand and emery paper etc as required for satisfactory completion of work.

The Contractor shall make his own arrangement for handling the tubes & fittings at the stores and transporting it to the site of installation.

In addition to the above, the Contractor shall follow all the relevant erection clauses/conditions stated under various chapters of this specification and erection/laying instructions provided by the manufacturer/supplier.

### 5.2. Technical specifications - Bought out Items

- **Tubes** shall be laid using poly amide box clamps on mounting rail supports.
- **Bending of tubing** shall be made with a tube bender. Bending radius shall be as following:
  - 1” and ¾” - 4D
  - ½” and ¼” - 3D
- All tube bends must be uniform with no kinks, flats or wrinkles.
- All the threaded joints shall be applied with oxygen compatible PTFE anaerobic thread sealant or as per manufacturer’s specifications.
- Compression/ Face seal fittings shall be installed as per manufacturer’s recommendations. Above ½” fittings shall be swaged with hydraulic/ pneumatic swaging machine.
- Once tubing installation is completed, the system shall be flushed with nitrogen (99.999%) to remove all foreign matters from inside the tubes and in accordance with the direction of the Engineer-In-Charge. Bypass or remove purifiers or other equipment that could be adversely affected before nitrogen flush out.
- All the completed lines shall be maintained in (+) ve pressure with Nitrogen (99.999%) to avoid contamination.
- Required gases should be arranged by the Contractor.
- Pipes / Tubes passing through masonry walls, beams, underground, foundations etc. shall be taken through cut-outs. If any pipe/tube requires embedded sleeve, the material of sleeve shall be SS-316 to avoid corrosion.
- Spacing between parallel runs of tubes carrying different services should be individually clamped and aligned as per the requirements.
- The clamps & supports shall be ensured to safely carry the weight of pipes.

5.3. Welding
- Tube to Tube or Tube to fittings/valves welding shall be done using automatic GTAW welding.
- All tubing headers shall be of seamless construction with joints welded using automatic orbital welding machine.
- Isometric drawing shall be prepared before start of welding work.
- Quality System of the Tubing Manufacturer shall have approval from ASME quality system certificate as material organization
- Tubing shall be clearly marked with heat code, lot code, outer diameter and wall thickness as in the inspection certificate.
- Tubing sizes up to 1” OD shall be bright annealed. Tubing with outside diameter larger than 1” OD shall be supplied in annealed and pickled condition.
- Tubing shall have carbon content < 0.030%
- Procedure needs to be qualified for welding machine, WPS, PQR, WPQR, etc... as per Section IX & X of the ASME
- Daily, the first and last production joint needs to go through external visual examination then cut open axially and check welding.
- All orbital weld joints below ½” OD shall be tested by Radiography test and above ½” OD shall be done by Borescope test.
- Proper edge preparation before welding different tubes / fitting, while carrying out the weld joints to ensure no cutting/welding burrs, other contaminants etc enter into the tubes.

5.4. Mode of Measurements Tubing’s:
Mode of Measurement for payment of items of tubing’s shall be as follows:
5.4.1. Tubing’s & Support:
These shall be measured as BOQ unit. Installed tubes, fittings & their supports will be measured in running meters including GI rail, threaded rod, stuff clamps, expansion bolts, nuts & washers etc. The quoted rates shall include sourcing of all such items viz. welding machine, tool and tackles, other support items etc. that are required to complete the work in all respects.

5.5. Guarantee:
The contractor shall guarantee that the materials and workmanship of the entire system are of the first class quality. All the equipment’s / apparatus shall be guaranteed to yield the specified ratings of discharge and quality. Any defective equipment / material / workmanship found short of the specified quality shall be rejected. Guarantee certificate of equipment’s from suppliers / manufacturers shall be handed over to the Engineer-In-Charge.
5.6. Defect Liability Period (DLP):
All the equipment, materials and complete Gas & Vacuum Piping System shall be guaranteed against defective material and workmanship for a period of 12 months from the date of commissioning and handing over of complete Gas & Vacuum Piping system to the Engineer-In-Charge along with all relevant documentation. The contractor shall repair, rectify and replace all the defective materials & components free of cost during DLP. In addition, routine, periodic and breakdown maintenance shall be carried out during the Defect Liability Period including replacement of all spares free of cost, as required.

5.7. Testing:
The entire segment of main, branch header and individual line connection piping will be flushed with Air or Nitrogen gas as specified before pressure testing is carried out. All compressed gases and compressed zero air lines that are connected with double compression joints and weld joints should be flushed with 99.99% pure compressed Nitrogen gas for ½ hrs. For all the compressed air lines, that are connected with double compression joints and weld joints should be flushed with compressed air as the media and should be flushed for ½ hrs.
While flushing keep open all the taps. By doing these the entire lengths of tubing will be flushed and will be clean with dust particles. While carrying-out the flushing operation pressure regulators, diaphragm valves etc. which are inline should be removed / bypassed.
The flushing has to be done in pressurized condition. During flushing intermittent valve opening and closing has to be done at all the final termination points.
After through flushing, the entire segment of main header, branch header and individual line connection piping will be pneumatically tested at least at 1.5 times the working pressure. (For e.g., 10 bar AWP, 15 bar ATP) . The line will be considered free of leakage only if the test pressure does not drop over a period of 24 hrs with line locked by specific testing gas as mentioned under:
- For Zero Air, Nitrogen, Mixed Gas and Carbon Dioxide gases the end connections will be double compression ferrule or threaded (NPT / BSP-P) type fittings.
- All the butt weld joints will be carried out by means of Orbital weld technique (Automatic TIG welding with Argon 99.999% as inert gas).
Supply of compressed air / helium / nitrogen / other gases required for testing and commissioning shall be in the scope of this tender and the same will not be provided by Client. No payment shall be made to contractor on this account.

Regulators:
a) Capacity of the respective regulators to be checked by varying:
Inlet pressure from 15 bars to 140 or 200 bars in case of Primary Regulators, maintaining constant pressure for range from 8 to 12 or 50 or 100 or 200 bars (as needed) on the downstream.
Inlet pressure from 8 bars to 30 bars in case of gas Secondary Regulators, maintaining constant pressure for ranges from 0 to 8 bars on the downstream.
Inlet pressure from 8 bars to 15 bars in case of air Pressure Regulators, maintaining constant pressure for ranges from 0 to 8 bars on the downstream.
b) All tests will be carried out in the Regulator manufacturer’s premises using compressed nitrogen gas and for gases other than compressed nitrogen, the Supplier / Contractor should indicate “equivalent air / gas flow rates” to be maintained during performance testing, corresponding to the actual flow rates indicated in the BOQ and P&ID’s.

c) The Contractor shall furnish a clear plan for the set-up and procedure that they propose to adopt for performance testing.

d) While every Primary Regulator will be subjected to performance test, 20% of the total number of Secondary Regulators in a given category will be taken up for performance testing. This number can be increased as may be decided by the Clients / PMC / consultant representative witnessing the tests, in case any regulator within the lot is found deviating from the specifications.

5.8. **Instruction Manual / Completion Drawings / Training:**

The contractor shall furnish detailed instruction and operation manual of the system in Quadruplicate. The contractor shall also furnish detailed completion drawings inclusive of control schematics, in quadruplicate if any. The contractor shall train the Engineer-In-Charges Personnel in the operation and maintenance of the system.

6. **DATA SHEETS & SPECIFICATIONS:**

6.1. **General Specification for SS Tubing:**

All the items shall meet the following specifications:

6.1.1. **Material of Construction:**

1. Seamless tubing shall be made of SS material and cold drawn instrumentation type. Tubing should be dual certified as TP 316 / 316L.
2. Seamless tubing should have a minimum of 2.5% molybdenum so as to ensure high resistance to corrosion.
3. Seamless tubing should have carbon content ≤ 0.030%.
4. Seamless tubing hardness should be max of HRB 90.
5. Seamless tubing sizes up to 1” OD should be bright annealed. Tubing with outside diameter larger than 1” OD should be supplied in annealed and pickled condition.
6. Seamless tubing shall have Tolerance on Wall Thickness ±10%.

6.1.2. **Design & Manufacture:**

- Seamless tubing manufacturer should have ISO 9001/9002 certification and as well as product approvals from TUV and JIS.
- Quality System of the Tubing Manufacturer should have approval from ASME quality system certification as material organization.
- Tolerance for 316/316L tubing from 6 to 42mm OD as per DIN/2391/ED 10305-I & tolerance on wall thickness should be +/-10%.
- Seamless tubes shall be certified as per NACE/ MR0175 for Hardness.
- Tubing shall be manufactured in an integrated Mill with hot extrusion process.

6.1.3. **Inspection & Testing:**
1. Testing of the Tubing should be in accordance with SS142353/142343, DIN 17456/58, NFA 49 – 117/217, ASTM A213, ASTM A269, ASTM A312, and EN 10216-5.

2. Tubing supplier should furnish an “INSPECTION CERTIFICATE” indicating:
   - Material description
   - Steel making process
   - Heat code
   - LOT code
   - Leak test: Eddy current test according to ASTM A-450
   - Test result of chemical composition, tensile test, hardness test, flaring test and flattening test.

6.1.4. **Test Reports & Certificates:**
   The manufacturer should supply material compliance certificate.

6.1.5. **Marking, Packing & Shipment:**
   1. All tubing must be clearly marked with heat code, lot code, outer diameter and wall thickness as in the inspection certification.
   2. Tubing shall be supplied with plugged ends.
   3. All the items shall be suitably wrapped and packaged to withstand rough handling during ocean shipment and inland journey.
   4. Items shall be wrapped and packaged in such a way that they can be preserved in original as new condition.

6.2. **General Specifications for SS Tube Fittings:**
   All the items shall meet the following specifications;

6.2.1. **Material of Construction**
   1. Fittings shall be manufactured from the following materials:-
      - Bar stock shall be SS 316 material as per ASTM A276/ASME SA 479, EN 1.4401 having carbon content less than 0.05% to provide increased resistance to corrosion.
      - Forgings shall be SS 316 material as per ASTM A182/ASME SA182 EN 1.4401.
   2. The fittings end connections shall be compatible with SS tube of hardness ≤ HRB 90.
   3. The stainless steel material, from which tube fitting bodies and components are made, will be restricted to a minimum chromium content of 17.0 % and a minimum nickel content of 12.0 % for improved corrosion resistance, and to a maximum carbon content of 0.05 %, which provides better corrosion-resistant weld ability.
   4. All component parts of the fittings shall be of the same material.
   5. The ferrule material shall be able to withstand an atmosphere of natural gas, oil and moisture without rusting.
   6. Every Component of fitting including front and back ferrule should be etched.

6.2.2. **Design & Manufacture**
1. All fittings shall be designed in conformance with the requirements of ASME B31.3 and applicable standards. Area classification applicable for all items shall be Class-1, Division-1, Group-D as per NEC Zone-1 Group-IIA/ II-B as per IS/ IEC specification or equivalent specification. All fittings shall be designed so that all parts/components meet the requirements for the specified area classification.

2. The tube fitting shall consist of the following precision machined parts:
   a) body,
   b) front ferrule,
   c) back ferrule and
   d) nut.
   The design configuration of all components shall present surface-to-surface contact, one part to another, keeping unit stresses below galling levels, for use on SS tubes conforming to ASTM A269 TP316.

3. Fittings shall be rated for at least the design pressure stipulated in the material requisition. The design of the fittings shall ensure that they shall be capable of holding full tube burst pressure after only one and a quarter turn pull up of the nut.

4. The threaded end of the fittings shall be NPT as per ASME B1.20.1, SAE AS 71051.

5. The fittings shall hold the tube with collecting action producing a firm grip on the tube without substantially reducing the tube wall thickness.

6. The fitting body shall not have any machined stop or shoulder to preclude additional tightening in subsequent make-up.

7. Fittings shall not torque the tubing during original or subsequent make-up of the connection and use geometry for inspection before and after make up the fittings shall not require disassembly for inspection before or after makeup.

8. All tube fittings shall be Gaugeable for sufficient pull up after one and quarter turn. All tube fittings shall have a gauge able shoulder and there will be no radius at the point where the shoulder meets the neck of the fitting body. A Gap Inspection Gage shall be used to check for insufficient pull-up.

9. The gap inspection gauge shall be easily insertable at finger tight position of nut. The gap inspection gauge shall not be insertable between the nut and shoulder of the fitting after completing only one and a quarter turn pull up of the nut.

10. The tube seat counter bore in the body shall be faced flat 90° to the axis of the tubing to minimize tube expansion and subsequent galling.

11. The sealing and gripping power of the fitting shall be controlled such that the action between ferrules will overcome commercial variations in tubing wall thickness, hardness, and diameter.

   i. **Front Ferrule**
      - The front ferrule shall provide a long, smooth repeatable seal by contact with body.
ii. **Back Ferrule**
   - The rear ferrule shall collet the tubing surface, improving the performance of the tubing in the systems of high impulse or vibration.
   - The back ferrule will have a uniform surface hardening. This surface hardening will be a low-temperature carburization, avoiding carbide formation. It will follow a disclosed and auditable process procedure.
   - The rear ferrule shall have a machine recess on the inside diameter and shall have complete surface hardening so as to substantially remove the required pull up torque. Both the requirements i.e. complete surface hardness and machined recess shall be met for all rear ferrules.

iii. Nuts shall have silver plated threads to act as a lubricating agent to avoid galling and to reduce tightening torque.

iv. Manufacturer shall be able to offer tube fittings with specially cleaned and packed to ensure compliance with product cleanliness requirements stated in ASTM G93 Level C for Oxygen.

v. All tube fittings provided by the supplier shall be NACE MR0175 certified by default.

### 6.2.3 Inspection & Testing

The manufacturer shall submit typical type test reports for the following test carried out on random samples of two ferrule fittings:

1. **Hydrostatic Pressure Test:** Fittings should undergo testing conducted to evaluate the tube gripping ability of assembled tube fittings to sustain hydraulic over pressure, attaining up to 3.5 times working pressure without hydraulic leakage and up to 4 times the working pressure without fitting material rupture or tube slippage.

2. **Helium Proof / Nitrogen Re-make Test:** Fittings should undergo testing conducted to evaluate the performance of tube fittings with 1.5 times the working pressure with Helium and at rated working pressure with Nitrogen after every re-make for 25 such re-makes.

3. **Helium Leak Test:** Fittings should undergo testing to ensure that leakage is not in excess of $1.0 \times 10^{-9}$ atm-CC/sec with the test assembly evacuated to approx. 20 millitorr while maintaining a differential pressure of 1 atm between the inside and outside of the assembly.

4. **Sodium Chloride Stress Test:** Fittings should undergo testing conducted to evaluate the effect of an environment that promotes stress corrosion cracking (SCC); conducted as per ASTM B117-95 standards.

5. **Rotary Flex Test:** Fittings should undergo testing conducted to evaluate the fatigue endurance reliability of tube fittings when installed on tubing subjected to fully reverse rotary beam flexure.

6. **Vibration Test:** Fittings should undergo testing conducted to evaluate the amount of cantilever deflection that can be applied to a tube and fitting assembly and still pass through 10,000,000 cycles without failure.
7. **Tube Burst Test**: Fittings should undergo testing conducted to evaluate the grip of tube fittings on tubing at the burst pressure of the tubing.

8. **Fire (Burn) Test with water quench**: Fittings should undergo testing conducted to evaluate the performance when exposed to a 1,500°F burn and a water quench based on API 607 standards.

9. **High Impact Shock Test**: Fittings should undergo testing conducted to evaluate the performance when subjected to shock test conducted as per ASTM F1387-99 standards. Should satisfy the requirements of ASTM F1387 Standards. The above shall be witnessed and certified by the U.S Department of Navy.

6.2.4. **Test Reports & Certificates**

1. The manufacturer should provide material compliance certificates.

2. Fittings manufacturer should have ISO 9001 certification and as well as product approvals from TUV, ASTM, ASME, BSI, DNV, GOST, Lloyds Registrar of Shipping & PED and also the most stringent fitting specification ASTM F1387, witnessed by the US Navy.

6.2.5. **Marking, Packing & Shipment**

1. Heat code traceability number shall be etched on both body and nut of each fitting. All fitting shall be etched to identify manufacturer and material.

2. Replacement nuts and ferrules shall be packaged in a manner so as to allow safe and simple replacement.

3. All the items shall be suitably wrapped and packaged to withstand rough handling during ocean shipment and inland journey.

4. Items shall be wrapped and packaged in such a way that they can be preserved in original as new condition.

5. Local Stock: Manufacturer or authorized distributor shall carry significant amount of stock to the tune of 500 nos of the tube fittings each in their local stocks.

6.2.6. **Documentation**

1. All documents shall be furnished in English language only.

2. At the time of bidding, bidder shall submit following documents:
   - Reference list of the previous supply for similar items, giving following details:
     - Name of the customer.
     - Specification of the item i.e. size & pressure and temperature rating.
     - Service
     - Quantity
     - Year of Supply
     - Test procedures and typical certificates to be submitted as per clause 5.3 and 5.4 of this specification.
     - Manufacturer Quality Control Plan and sampling plan.
     - Copy of ISO 9000 certification for supplier/ manufacturer.
     - The manufacturer should supply material compliance certificate.

6.2.7. **Warranty**
Manufacturer & its authorized distributors should offer a comprehensive Warranty covering the performance of the product against any defects in material or workmanship for 2 years’ time after commissioning and handing over of the product. A certificate to this effect must be issued on their respective Company letter head.

6.3. **General Specification for Manual Changeover Regulators:**
All the items shall meet following specifications.

6.3.1. **Material of Construction**
1. The Regulator body, stem & range spring shall made of SS 316.
2. Material of construction of the diaphragm shall be Hastelloy/ Alloy X-750 Diaphragm/SS316
3. Material of construction of seat shall be either PCTFE or PEEK depending on the pressure rating of the regulator.
4. All wetted lubricants must be PTFE based.

6.3.2. **Design & Manufacture**
1. All manual changeover manifolds shall ensure continuous gas delivery by manual switching between sources to extend gas supply.
2. Diaphragm sensing regulators enable precise pressure regulation. In order to achieve greater sensitivity and longer life, a convoluted diaphragm shall be used.
3. All changeover manifolds must have a Supply Pressure Effect of approx. 0.01%.
4. All changeover manifolds shall be supplied as a complete system with tube fittings, inlet/outlet/vent valves, pressure gauges & suitable single & double stage pressure reducing regulators mounted suitably on a SS 316 panel, except for manifolds supplied for Oxygen service. All regulators used must comply with the specifications listed below.
5. All regulators shall have a two piece design that offers linear load on the diaphragm seal when the cap ring is tightened, eliminating torque damage to the diaphragm during assembly.
6. The diaphragm of the pressure regulator shall have a convoluted, no perforated design ensuring greater sensitivity and longer life.
7. All pressure reducing regulators must include a 25µm filter that is held in the inlet port to prevent any foreign particles from entering the regulator. In addition the filter must be supported by a retainer ring to prevent it from accidently falling out.
8. The poppet must be supported by a poppet damper to keep the poppet aligned thereby reducing vibration & resonance.
9. The diaphragm shall be supported by a braced stop plate to protest against a ruptured diaphragm.
10. All changeover manifolds & all components for Oxygen system shall be suitably cleaned for Oxygen service and quoted accordingly.
11. Manufacturer shall be able to Regulators with specially cleaned and packed to ensure compliance with product cleanliness requirements stated in ASTM G93 Level C for oxygen service.
12. All Regulators used must meet the technical specification listed in the earlier part of this document.

6.3.3. **Inspection & Testing**
1. Shell testing shall be performed on all components to a requirement of no detectable leakage with a liquid detector at 80 psig (5.5 bar) nitrogen.
2. All regulators must be 100 % factory tested for changeover pressure.

6.3.4. **Test Reports & Certificates**
1. The manufacturer shall supply material compliance certificate.
2. Regulator manufacturer should have ISO 9001 certification and as well as product approvals from TUV, ASTM, ASME, BSI, DNV, GOST, Lloyds Registrar of Shipping & PED.

6.3.5. **Marking, Packing & Shipment**
1. Heat code shall be marked on Regulator body to facilitate traceability. All Regulators shall be etched to identify manufacturer and material.
2. All the items shall be suitably wrapped and packaged to withstand rough handling during ocean shipment and inland journey.
3. Each item shall be properly tagged and package separately to facilitate easy identification.
4. All items shall be wrapped and packaged in such a way that they can be preserved in original as new condition.

6.3.6. **Warranty**
Manufacturer & its authorized distributors should offer a Warranty covering the performance of the product against any defects in material or workmanship for 2 years after commissioning and handing over of the product. A certificate to this effect must be issued on their respective Company letter head.

6.4. **General Specification for Ball Valves:**
All the items shall meet following specifications.

6.4.1. **Material of Construction**
1. The valve shall be of Single piece design with forged / machined body made of material conforming to ASTM A479 & A276 Type SS 316.
2. Material of construction of ball stem shall confirm to ASTM A276 Type SS 316.
3. Material of construction of packing shall be Modified PTFE / D1710 type 1, Grade 1, Class B.
4. Manufacturer shall be able to provide multiple options for seat packing materials Reinforced PTFE, Alloy X-750, Carbon/glass PTFE, PEEK & UHMWPE.
5. Manufacturer shall be able to provide multiple options for stem packing materials maintenance kits and colour handle kits.

6.4.2. **Design & Manufacture**
1. Valve shall employ a live-loaded packing system that reduces need for packing adjustment improves thermal cycle performance and compensates for wear.
2. Packing shall be a single-piece design constructed of modified PTFE which reduces potential leak points and has virtually no dead space. Valve sizes above 3/8” shall have standard PTFE packing.
3. Manufacturer shall be able to offer Ball Valves with specially cleaned and packed to ensure compliance with product cleanliness requirements stated in ASTM G93 Level C for oxygen service.

4. Design pressure shall be at least twice the working pressure & Burst pressure may be almost four times the working pressure of the ball valves.

5. The back ferrule of Ball Valves’ end fitting shall have a machined recess on the inside diameter and shall have complete surface hardening to substantially reduce the required pull up torque. Both the requirements i.e., complete surface hardness and machined recess shall be met for all rear ferrules of sizes ranging from ¼” to 1” OD & 6mm to 25mm OD.

6. All Ball Valves with SS Nut & Ferrule end fittings shall have a gaugeable shoulder.

7. Single piece ball Valve shall employ a balanced trunion, patent –pending design that supports packing volume, minimizing thermal effect.

6.4.3. Inspection & Testing
1. The valve shall be factory tested with Nitrogen at 1000 psig (69 bar). Maximum allowable seat leakage shall be 0.1 std cc/min.

6.4.4. Test Reports & Certificates
1. The manufacturer shall supply material compliance certificate.
2. For Sour Gas service - Materials for wetted components are selected in accordance with NACE Specification MR0175 for sulfide stress cracking resistant materials.
3. Valve manufacturer should have ISO 9001 certification and as well as product approvals from TUV, ASTM, ASME, BSI, DNV, GOST, Lloyds Registrar of Shipping & PED.
4. Valves are helium leak tested at a pressure of 1 x 10–4 Torr. The maximum allowable leak rate is 4 x 10–9 std cm3/s.

6.4.5. Marking, Packing & Shipment
1. Heat code shall be marked on valve body to facilitate traceability. All valves shall be etched to identify manufacturer and material.
2. All the items shall be suitably wrapped and packaged to withstand rough handling during ocean shipment and inland journey.
3. All items shall be wrapped and packaged in such a way that they can be preserved in original as new condition.

6.4.6. Warranty
Manufacturer & its authorized distributors should offer a Warranty covering the performance of the product against any defects in material or workmanship for 2 years after commissioning and handing over of the product. A certificate to this effect must be issued on their respective Company letter head.

6.5. General Specification for Needle Valves:
All the items shall meet following specifications.

6.5.1. Material of Construction
1. All 316 SS Needle valves body to conform to ASTM A182/ A479 and stem material, packing nut to conform with 316 SS/A276.
2. Material of construction of Upper and lower packing shall be PFA/D3307.
3. Manufacturer shall be able to provide multiple options for seat packing materials kits, lockable handles and colour handles kits.
4. Manufacturer should be able to provide multiple options for stem packing materials, O-ring maintenance kits and colour handle kits.
5. Manufacturer shall be able to provide multiple options for O ring materials like Buna C, Buna N, Ethylene propylene & Karlez.
6. All Needle Valves with SS Nut & Ferrule end fittings shall have a gaugeable shoulder.

6.5.2. **Design & Manufacture**
1. Manufacturer shall be able to provide needle valves either with Integral bonnet / Union bonnet design.
2. The back ferrule of Needle Valves’ end fitting shall have a machined recess on the inside diameter and shall have complete surface hardening to substantially reduce the required pull up torque. Both the requirements i.e., complete surface hardness and machined recess shall be met for all rear ferrules of sizes ranging from ¼” to 1” OD & 6mm to 25mm OD.
3. Manufacturer shall be able to offer Needle Valves with specially cleaned and packed to ensure compliance with product cleanliness requirements stated in ASTM G93 Level C for oxygen service.
4. All Needle Valves with SS Nut & Ferrule end fittings shall have a gaugeable shoulder.
5. Manufacturer shall be able to offer atleast 3 types of stem tip designs to suit for different applications parameters.

6.5.3. **Inspection & Testing**
1. The valve shall be factory tested with Nitrogen at 1000 psig (69 bar). Maximum allowable seat leakage shall be 0.1 std cc/min.
2. Design pressure should be at least twice the working pressure & Burst pressure may be almost four times the working pressure of the Needle valves.

6.5.4. **Test Reports & Certificates**
1. The manufacturer shall supply material compliance certificate.
2. For Sour Gas service - Materials for wetted components are selected in accordance with NACE Specification MR0175 for sulfide stress cracking resistant materials.
3. Valve manufacturer should have ISO 9001 certification and as well as product approvals from TUV, ASTM, ASME, BSI, DNV, GOST, Lloyds Registrar of Shipping & PED.

6.5.5. **Marking, Packing & Shipment**
1. Heat code shall be marked on valve body to facilitate traceability. All valves shall be etched to identify manufacturer and material.
2. All the items shall be suitably wrapped and packaged to withstand rough handling during ocean shipment and inland journey.
3. Each item shall be properly tagged separately to facilitate easy identification.
4. All items shall be wrapped and packaged in such a way that they can be preserved in original as new condition.

6.5.6. **Warranty**
Manufacturer & its authorized distributors should offer a Warranty covering the performance of the product against any defects in material or workmanship for 2 years after commissioning and handing over of product. A certificate to this effect must be issued on their respective Company letter head.

6.6. **General Specification For Check Valves:**
All the items shall meet following specifications.

6.6.1. **Material of Construction**
1. Check valve body and poppet to conform to 316 SS / A479.
2. If the check valve has an elastomer as a wetted component, a variety of sealing materials shall be made available.
3. Manufacturer shall be able to provide multiple options for Seal kits.
4. For corrosive gases If the check valve has an elastomer as a wetted component, a variety of sealing materials including Kalrez and Teflon shall be made available.
5. All Check Valves with SS Nut & Ferrule end fittings shall have a gaugeable shoulder.

6.6.2. **Design & Manufacture**
The back ferrule of Check Valves’ end fitting shall have a machined recess on the inside diameter and shall have complete surface hardening to substantially reduce the required pull up torque. Both the requirements i.e., complete surface hardness and machined recess shall be met for all rear ferrules of sizes ranging from ¼” to 1” OD & 6mm to 25mm OD.
1. Manufacturer shall be able offer Check Valves with specially cleaned and packed to ensure compliance with product cleanliness requirements stated in ASTM G93 Level C for oxygen service.
2. All Check Valves with SS Nut & Ferrule end fittings shall have a gaugeable shoulder.
3. Check Valve with fixed pressure, are cycled six times prior testing, every check valve is tested to ensure it seals within 5’s at the appropriate seal pressure.

6.6.3. **Inspection & Testing**
1. The valve shall be factory tested with Nitrogen at 1000 psig (69 bar). Maximum allowable seat leakage shall be 0.1 std cc/min.
2. Design pressure should be at least twice the working pressure & Burst pressure may be almost four times the working pressure of the Check valves.

6.6.4. **Test Reports & Certificates**
1. Manufacture should provide material compliance certificate.
2. Valve manufacturer should have ISO 9001 certification and as well as product approvals from TUV, ASTM, ASME, BSI, DNV, GOST, Lloyds Registrar of Shipping & PED.

6.6.5. **Marking, Packing & Shipment**
1. Heat code shall be marked on valve body to facilitate traceability. All Check Valves shall be etched to identify manufacturer and material.
2. All the items shall be suitably wrapped and packaged to withstand rough handling during ocean shipment and inland journey.
3. Each item shall be properly tagged and package separately to facilitate easy identification.
4. All items shall be wrapped and packaged in such a way that they can be preserved in original as new condition.

6.6.6. **Warranty**
Manufacturer & its authorized distributors should offer a Warranty covering the performance of the product against any defects in material or workmanship for 2 years after commissioning and handing over of the product. A certificate to this effect must be issued on their respective Company letter head.

6.7. **General Specification for Hose:**
All the items shall meet following specifications.

6.7.1. **Material of Construction**
1. Manufacturer should able to offer Hose with 316 SS over braid.
2. Manufacturer shall provide 316L SS core & 316L SS braided hoses where permeation is undesirable.
3. All 316 SS Hoses end connections for the hose assembly can be permanent (crimped) design or reusable (compression style).

6.7.2. **Design & Manufacture**
1. Manufacturer shall be able to provide multiple cover options without changing hose technical data.
2. Manufacturer shall provide an option of carbon black filled PTFE core for applications that require static dissipation.
3. All Hoses with SS Nut & Ferrule end fittings shall have a gauge able shoulder. There will be no radius at the point where the shoulder meets the neck of the fitting body. The gaugeable shoulder will allow a Gap Inspection Gage to be inserted between the nut and shoulder; 180 deg. flush around the neck of the fitting, to check for insufficient pull-up. The Gap Inspection Gage will not fit between the nut and shoulder of a sufficiently pulled-up fitting on the initial pull up and it must be consistently reliable.
4. All Hoses with SS Nut & Ferrule end fittings shall have a gaugeable shoulder.

6.7.3. **Inspection & Testing**
1. Every assembly is pressure tested with water at room temperature for 30 seconds to a requirement of no detectable leakage. Testing is performed at 1000 psig (69 bar), or 225 psig (15.5 bar) if an end connection is rated below 1000 psig (69 Bar).
2. Design pressure should be at least twice the working pressure & Burst pressure may be almost four times the working pressure of the Hoses.

6.7.4. **Test Reports & Certificates**
1. The manufacturer shall supply material compliance certificate.
2. PTFE material complies with FDA regulation 21 CFR Part 177.1550, USP <88> Class VI, and 3-A.

6.7.5. **Marking, Packing & Shipment**
   1. Heat code shall be marked on hose to facilitate traceability. All Hoses shall be etched to identify manufacturer and material.
   2. All the items shall be suitably wrapped and packaged to withstand rough handling during ocean shipment and inland journey.
   3. Each item shall be properly tagged and package separately to facilitate easy identification.
   4. All items shall be wrapped and packaged in such a way that they can be preserved in original as new condition.

6.7.6. **Warranty**
Manufacturer & its authorized distributors should offer a Warranty covering the performance of the product against any defects in material or workmanship for 2 years after commissioning and handing over of the product. A certificate to this effect must be issued on their respective Company letter head.

6.8. **General Specification for Filters:**
All the items shall meet following specifications.

6.8.1. **Material of Construction**
   1. Filter body, bonnet & bonnet nut to conform to 316 SS / A479.
   2. The minimum nominal pore size of filter element shall be 0.5µm.
   3. The filter element shall be of grade SS 316.
   4. Maintenance kits shall be made available for field replacements.
   5. All Filters with SS Nut & Ferrule end fittings shall have a gaugeable shoulder.

6.8.2. **Design & Manufacture**
   1. All filters with SS Nut & Ferrule end fittings shall have a gaugeable shoulder. There will be no radius at the point where the shoulder meets the neck of the fitting body. The gaugeable shoulder will allow a Gap Inspection Gage to be inserted between the nut and shoulder; 180 deg. flush around the neck of the fitting, to check for insufficient pull-up. The Gap Inspection Gage will not fit between the nut and shoulder of a sufficiently pulled-up fitting on the initial pull up and it must be consistently reliable.
   2. The back ferrule of filter’s end fitting shall have a machined recess on the inside diameter and shall have complete surface hardening to substantially reduce the required pull up torque. Both the requirements i.e., complete surface hardness and machined recess shall be met for all rear ferrules of sizes ranging from ¼” to 1” OD & 6mm to 25mm OD.
   3. Manufacturer shall be able to offer Filters with specially cleaned and packed to ensure compliance with product cleanliness requirements stated in ASTM G93 Level C for oxygen service.
   4. Design pressure shall be at least twice the working pressure & Burst pressure may be almost four times the working pressure of Filters.
   5. All Filters with SS Nut & Ferrule end fittings shall have a gaugeable shoulder.
6.8.3. Inspection & Testing
1. Every Filter shall be factory tested with Nitrogen at 1000 psig (69 Bar) to a requirement of no detectable leakage with liquid leak detector.

6.8.4. Test Reports & Certificates
1. The manufacturer shall supply material compliance certificate.
2. For Sour Gas service - Materials for wetted components are selected in accordance with NACE Specification MR0175 for sulfide stress cracking resistant materials.
3. Filter manufacturer should have ISO 9001 certification and as well as product approvals from TUV, ASTM, ASME, BSI, DNV, GOST, Lloyds Registrar of Shipping & PED.

6.8.5. Marking, Packing & Shipment
1. Heat code shall be marked on Filter to facilitate traceability. All Filters shall be etched to identify manufacturer and material.
2. All the items shall be suitably wrapped and packaged to withstand rough handling during ocean shipment and inland journey.
3. Each item shall be properly tagged separately to facilitate easy identification.
4. All items shall be wrapped and packaged in such a way that they can be preserved in original as new condition.

6.8.6. Warranty
Manufacturer & its authorized distributors should offer a Warranty covering the performance of the product against any defects in material or workmanship for 2 years after commissioning and handing over of the product. A certificate to this effect must be issued on their respective Company letter head.

6.9. Other Mandatory Requirements
a) The bidders must enclose a client list, contact details, relevant brochures and compliance certificate (Annexure I) with the tender.
b) The bidders should be well established firms preferably leaders in the application stated above and must have a proven track record of completing atleast 5 Projects with product supply valued > 20L each. Firms should be in existence for atleast 2 years.
c) Bidders to submit their reference list of Tubing, Pressure Regulators, Valves and Tube fittings and accessories as mentioned in the tender, supplied for similar services along with offer.
The reference list must include the following:
- Proven Track Record
- Process fluid type, outlet temperature rating.
- Year of supply
- Client’ s name & address
- Client contact details
d) Established commitment to technical support in India, preferably Bangalore should be demonstrated.
e) The Suppliers must have one stop shop for all Fluid components including Fittings, Valves, Tubing, Hoses, Regulators, Gauges, Manifolds, Filters and Quick Connectors etc...

f) Products should have average leak rate close to zero as evident from Leak surveys for lower operating costs.

g) The Supplier should have Proven track record for Excellent technical support, Help in product selection, training, Technical update etc.

h) The authorized representative of the manufacturer shall have the ability to conduct Installation Training Program & with a past record of having conducted more than 10 such programs during the previous 1 year period.

i) The authorized representative of the manufacturer shall have the ability to conduct Leak Audits and with a past record of having conducted more than 10 such programs during the previous 1 year period.

7. SYSTEM COMPONENTS

7.1.1. M.S. fabricated support framework for in Cylinders and Manifolds

Construction : Arc Welding and Bolting.

Finish : One Coat of Primer & two Coates Synthetic enamel paint.

Material Used: MS. Channel /Angle/ Plate as per IS: 808/1730 / 1731

7.1.2. Cylinder Brackets with Chain

MOC: Powder coated M.S. with powder coated G.I. chain

Aesthetically designed gas cylinder brackets with powder coated chain suitable for holding the cylinder securely in upright position.

7.1.3. Nut Bullnose

Specifications: ¼” NPTM X 5/8” BSP RH /LH nut suitable for individual gas.

MOC: Bullnose : SS 316

Nut : Barstock Brass

7.2. General Specification for SS316 Pipes:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>SERVICE MEDIA</th>
<th>CA, N2, DM &amp; POTABLE WATER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DESIGN</td>
<td>BASE MATERIAL : STAINLESS STEEL SS - 316</td>
</tr>
<tr>
<td></td>
<td>CONDITIONS</td>
<td>RATING &amp; FACING : 150 # .</td>
</tr>
<tr>
<td>PIPE</td>
<td></td>
<td>CORROSION ALLOWANCE : NIL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MAX W.P : 5.0 KG/CM2 ( G )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ITEM</th>
<th>SIZE</th>
<th>TYPE</th>
<th>MATERIAL</th>
<th>DIMENSION</th>
<th>THK/RATING</th>
<th>ENDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB - MM</td>
<td>FROM TO</td>
<td>15 40</td>
<td>ERW</td>
<td>A312 TP 316</td>
<td>ANSI B 36.19</td>
<td>SCH. 40S</td>
</tr>
<tr>
<td>25</td>
<td>ERW</td>
<td>A312 TP 316</td>
<td>ANSI B</td>
<td>SCH. 10S</td>
<td>B.E</td>
<td></td>
</tr>
<tr>
<td>FLANGES</td>
<td>15 150</td>
<td>SORF</td>
<td>ASTM A182 F316</td>
<td>ANSI B 16.5</td>
<td>150 #</td>
<td>R.F</td>
</tr>
<tr>
<td>--------</td>
<td>--------</td>
<td>------</td>
<td>----------------</td>
<td>-------------</td>
<td>-------</td>
<td>-----</td>
</tr>
<tr>
<td>BLIND</td>
<td>15 40</td>
<td>PLATE</td>
<td>ASTM A182 F316</td>
<td>ANSI B 16.5</td>
<td>150 #</td>
<td>R.F</td>
</tr>
<tr>
<td>ELBOW</td>
<td>15 40</td>
<td>WELDED</td>
<td>A 403 GR WPW 316</td>
<td>ANSI B 16.9</td>
<td>SCH. 40S</td>
<td>B.E</td>
</tr>
<tr>
<td>ELBOW</td>
<td>50 150</td>
<td>WELDED</td>
<td>A 403 GR WPW 316</td>
<td>ANSI B 16.9</td>
<td>SCH. 10S</td>
<td>B.E</td>
</tr>
<tr>
<td>REDUCER</td>
<td>15 40</td>
<td>WELDED</td>
<td>A 403 GR WPW 316</td>
<td>ANSI B 16.9</td>
<td>SCH. 40S</td>
<td>B.E</td>
</tr>
<tr>
<td>ECC</td>
<td>50 150</td>
<td>WELDED</td>
<td>A 403 GR WPW 316</td>
<td>ANSI B 16.9</td>
<td>SCH. 10S</td>
<td>B.E</td>
</tr>
<tr>
<td>REDUCER</td>
<td>15 40</td>
<td>WELDED</td>
<td>A 403 GR WPW 316</td>
<td>ANSI B 16.9</td>
<td>SCH. 40S</td>
<td>B.E</td>
</tr>
<tr>
<td>CONC</td>
<td>50 150</td>
<td>WELDED</td>
<td>A 403 GR WPW 316</td>
<td>ANSI B 16.9</td>
<td>SCH. 10S</td>
<td>B.E</td>
</tr>
<tr>
<td>TEES</td>
<td>15 40</td>
<td>WELDED</td>
<td>A 403 GR WPW 316</td>
<td>ANSI B 16.9</td>
<td>SCH. 40S</td>
<td>B.E</td>
</tr>
<tr>
<td>TEES</td>
<td>50 150</td>
<td>WELDED</td>
<td>A 403 GR WPW 316</td>
<td>ANSI B 16.9</td>
<td>SCH. 10S</td>
<td>B.E</td>
</tr>
<tr>
<td>CAPS</td>
<td>15 40</td>
<td>WELDED</td>
<td>A 403 GR WPW 316</td>
<td>ANSI B 16.9</td>
<td>SCH. 40S</td>
<td>B.E</td>
</tr>
<tr>
<td>CAPS</td>
<td>50 150</td>
<td>WELDED</td>
<td>A 403 GR WPW 316</td>
<td>ANSI B 16.9</td>
<td>SCH. 10S</td>
<td>B.E</td>
</tr>
<tr>
<td>STUB</td>
<td>15 40</td>
<td>SMLS</td>
<td>A 403 GR WPW 316</td>
<td>ANSI B 16.9</td>
<td>SCH. 40S</td>
<td>B.E</td>
</tr>
<tr>
<td>ENDS</td>
<td>50 150</td>
<td>SMLS</td>
<td>A 403 GR WPW 316</td>
<td>MSS.SP 43</td>
<td>SCH. 10S</td>
<td>B.E</td>
</tr>
<tr>
<td>GASKETS</td>
<td>15 150</td>
<td>RING TYPE</td>
<td>PTFE</td>
<td>ANSI B 16.21</td>
<td>3 MM</td>
<td></td>
</tr>
<tr>
<td>BOLTING</td>
<td>ALL</td>
<td>STUDS &amp; HEAVY</td>
<td>A 193 GR B8</td>
<td>ANSI B 1.1</td>
<td>FULLY</td>
<td></td>
</tr>
<tr>
<td>BOLTING</td>
<td>ALL</td>
<td>HEX NUTS</td>
<td>A 194 GR 8</td>
<td>ANSI B 18.82</td>
<td>THREADED</td>
<td></td>
</tr>
</tbody>
</table>

### 7.3. General Specification for SS316 Valves

<table>
<thead>
<tr>
<th>SL NO</th>
<th>TYPE</th>
<th>BALL VALVE(SS 316)</th>
<th>SL NO</th>
<th>INFO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BODY</td>
<td>ASTM A182Gr F-316</td>
<td>17</td>
<td>VACUUM</td>
</tr>
<tr>
<td>2</td>
<td>ENDS</td>
<td>NB 15-50 mm Socket weld</td>
<td>18</td>
<td>PACKING</td>
</tr>
<tr>
<td>3</td>
<td>FLANGE HOLES</td>
<td>AS PER ANSI.B.16.5</td>
<td>19</td>
<td>STUDS &amp; NUTS</td>
</tr>
<tr>
<td>4</td>
<td>MFG. STD</td>
<td></td>
<td>20</td>
<td>MAX TEMP</td>
</tr>
<tr>
<td>5</td>
<td>RATING</td>
<td>150 # RATING</td>
<td>21</td>
<td>MIN TEMP</td>
</tr>
</tbody>
</table>
### 7.4. Specification of Pressure Gauge:

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>SPECIFICATION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Model no.</td>
<td>To be specified by vendor</td>
</tr>
<tr>
<td>2</td>
<td>Dial size</td>
<td>4”</td>
</tr>
<tr>
<td>3</td>
<td>Bottom entry size</td>
<td>3/8” BSP</td>
</tr>
<tr>
<td>4</td>
<td>Diaphragm</td>
<td>SS 316</td>
</tr>
<tr>
<td>5</td>
<td>Contact parts</td>
<td>SS316/SS316 Teflon Lined/Haste alloy</td>
</tr>
<tr>
<td>6</td>
<td>Movement</td>
<td>SS 316</td>
</tr>
<tr>
<td>7</td>
<td>Block</td>
<td>SS 316</td>
</tr>
<tr>
<td>8</td>
<td>Design range</td>
<td>Upto 15 Kg/cm²</td>
</tr>
<tr>
<td>9</td>
<td>Operating range</td>
<td>As per BOQ</td>
</tr>
<tr>
<td>10</td>
<td>Accuracy</td>
<td>+ / - 1 % of range span</td>
</tr>
<tr>
<td>11</td>
<td>Over range protection</td>
<td>125 %</td>
</tr>
<tr>
<td>12</td>
<td>Case &amp; bezel</td>
<td>SS 316 with screwed Bezel of ABS plastic.</td>
</tr>
<tr>
<td>13</td>
<td>Mounting</td>
<td>Direct with bottom entry</td>
</tr>
<tr>
<td>14</td>
<td>Standard fitments</td>
<td>Micro adjustable pointer (internal) blow out disc.</td>
</tr>
<tr>
<td>15</td>
<td>Documentation</td>
<td>Calibration certificate traceable to National Standard.</td>
</tr>
</tbody>
</table>

### 7.5. Specification of Temperature Gauge:

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>SPECIFICATION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dial size</td>
<td>4”</td>
</tr>
<tr>
<td>2</td>
<td>Bottom entry size</td>
<td>3/8”</td>
</tr>
<tr>
<td>3</td>
<td>Case /entry</td>
<td>Cast Aluminium weather proof / Bottom</td>
</tr>
<tr>
<td>4</td>
<td>System</td>
<td>Hg in Steel</td>
</tr>
<tr>
<td>5</td>
<td>Temperature range</td>
<td>0 to 50 deg C</td>
</tr>
<tr>
<td>6</td>
<td>Accuracy</td>
<td>± 1 % FSD</td>
</tr>
<tr>
<td>7</td>
<td>Over range protection</td>
<td>130 %</td>
</tr>
<tr>
<td>8</td>
<td>Stem material</td>
<td>SS 316L</td>
</tr>
</tbody>
</table>
7.6. General Specification for CI Ball Valves

<table>
<thead>
<tr>
<th>SL NO</th>
<th>TYPE</th>
<th>BALL VALVE (CS)</th>
<th>SL NO</th>
<th>INFO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BODY</td>
<td>ASTM A216 Gr.WCB</td>
<td>17</td>
<td>VACUUM</td>
</tr>
<tr>
<td>2</td>
<td>ENDS</td>
<td>NB 15-50 mm Socket weld</td>
<td>18</td>
<td>GLAND PACKING</td>
</tr>
<tr>
<td>3</td>
<td>FLANGE HOLES</td>
<td>AS PER ANSI B.16.5</td>
<td>19</td>
<td>STUDS &amp; NUTS</td>
</tr>
<tr>
<td>4</td>
<td>MFG. STD</td>
<td>BS 5351/API 6D/API 608/ BS 5146</td>
<td>20</td>
<td>MAX TEMP 150 °C</td>
</tr>
<tr>
<td>5</td>
<td>RATING</td>
<td>150 # RATING</td>
<td>21</td>
<td>MIN TEMP -20 °C</td>
</tr>
<tr>
<td>6</td>
<td>BORE</td>
<td>FULL PORT</td>
<td>22</td>
<td>MAX PRES 10 Bar g</td>
</tr>
<tr>
<td>7</td>
<td>BALL</td>
<td>CF 8</td>
<td>23</td>
<td>MIN PRES FV</td>
</tr>
<tr>
<td>8</td>
<td>BODY GASKET</td>
<td>PTFE VIRGIN</td>
<td>24</td>
<td>MAKE</td>
</tr>
<tr>
<td>9</td>
<td>TRIM</td>
<td>CF 8</td>
<td>25</td>
<td>Hydro test</td>
</tr>
<tr>
<td>10</td>
<td>SEATING</td>
<td>PTFE VIRGIN</td>
<td>26</td>
<td>BODY 30 bar g</td>
</tr>
<tr>
<td>11</td>
<td>LEVER</td>
<td>AISI-316</td>
<td>27</td>
<td>Hyd seat 21 bar g</td>
</tr>
<tr>
<td>12</td>
<td>STEM</td>
<td>AISI-316/316</td>
<td>28</td>
<td>Pneumatic 7 bar g</td>
</tr>
<tr>
<td>13</td>
<td>STEM SEAL</td>
<td>PTFE RENEWABLE</td>
<td>29</td>
<td>CONSTRUCTION 2 OR 3 PIECES</td>
</tr>
<tr>
<td>14</td>
<td>GLAND</td>
<td>AISI 316</td>
<td>30</td>
<td>Others Stem blow out proof</td>
</tr>
<tr>
<td>15</td>
<td>HANDLE</td>
<td>GI WITH PVC COVER</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>SERVICE</td>
<td>UTILITY</td>
<td>32</td>
<td></td>
</tr>
</tbody>
</table>

7.7. General Specification for Instrument Air Regulator:

AIR FILTER DATA SHEET

<table>
<thead>
<tr>
<th>SL NO</th>
<th>DESCRIPTIONS</th>
<th>DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SERVICE</td>
<td>AIR</td>
</tr>
<tr>
<td>2</td>
<td>TYPE</td>
<td>DIAPHRAGM, RELIEVING</td>
</tr>
<tr>
<td>3</td>
<td>ADJUSTING SCREW</td>
<td>REQUIRED</td>
</tr>
<tr>
<td>4</td>
<td>DRAIN</td>
<td>MANUAL</td>
</tr>
<tr>
<td>5</td>
<td>REGULATION</td>
<td>OUTLET PRESSURE VARIATION NOT MORE THAN 1% FROM SET VALUE FOR INLET PRESSURE VARIATION OF 10%</td>
</tr>
<tr>
<td>6</td>
<td>OVER RANGE PROTECTION</td>
<td>150% OF INLET PRESSURE</td>
</tr>
<tr>
<td>No.</td>
<td>Specification</td>
<td>Requirement</td>
</tr>
<tr>
<td>-----</td>
<td>---------------------------------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>7</td>
<td>Outlet Pressure Gauge</td>
<td>REQUIRED</td>
</tr>
<tr>
<td>8</td>
<td>Gauge Dial Size</td>
<td>50 mm</td>
</tr>
<tr>
<td>9</td>
<td>Gauge Color Dial/ Numerals</td>
<td>WHITE/BLACK</td>
</tr>
<tr>
<td>10</td>
<td>Gauge Accuracy</td>
<td>± 2%</td>
</tr>
<tr>
<td>11</td>
<td>Case</td>
<td>IP54 AS PER IS 13947(P-1)</td>
</tr>
<tr>
<td>12</td>
<td>Color</td>
<td>MFG STD, EPOXY FINISH</td>
</tr>
<tr>
<td>13</td>
<td>Mounting Bracket</td>
<td>REQUIRED</td>
</tr>
<tr>
<td>14</td>
<td>Housing(Body) Material</td>
<td>DIE CAST ALUMINUM/BRASS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(NICKEL/CHORME PLATED)</td>
</tr>
<tr>
<td>15</td>
<td>Diaphragm Material</td>
<td>BUNA N, NYLON REINFORCED</td>
</tr>
<tr>
<td>16</td>
<td>Instrument Valve</td>
<td>SS 316/SS 316</td>
</tr>
<tr>
<td>17</td>
<td>Spring Material</td>
<td>SS 316/SS 316</td>
</tr>
<tr>
<td>18</td>
<td>Inner Valve Material</td>
<td>SS 316/SS 316</td>
</tr>
<tr>
<td>19</td>
<td>Trim Material</td>
<td>SS 316/SS 316</td>
</tr>
<tr>
<td>20</td>
<td>Packing Material</td>
<td>TEFLOWN/BUNA N</td>
</tr>
<tr>
<td>21</td>
<td>Gauge Pressure Element/Movement Material</td>
<td>PHOSPHOR BRONZE</td>
</tr>
<tr>
<td>22</td>
<td>Gauge Housing Material</td>
<td>ALUMINUM/BRASS (NICKEL/CHORME PLATED)</td>
</tr>
<tr>
<td>23</td>
<td>Gauge Ring Material</td>
<td>SHATTER PROOF/CLEAR ACRYLIC SHEET</td>
</tr>
<tr>
<td>24</td>
<td>Gauge Glass</td>
<td>SHATTER PROOF/CLEAR ACRYLIC SHEET</td>
</tr>
<tr>
<td>25</td>
<td>Inlet Connection</td>
<td>1/2&quot; /3/4&quot; NPT(FEMALE)</td>
</tr>
<tr>
<td>26</td>
<td>Outlet Connection</td>
<td>1/2&quot; /3/4&quot; NPT(FEMALE)</td>
</tr>
<tr>
<td>27</td>
<td>Applicable Codes and STDs</td>
<td>1.IS-319, ANSI-B.1.20.1,ASTM-D-454</td>
</tr>
<tr>
<td>28</td>
<td>Tests</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Dimensional and Thread Check</td>
<td>100 % ITEMS</td>
</tr>
<tr>
<td>30</td>
<td>Air Leak Test</td>
<td>AT 1.25 TIMES THE DESIGN PRESSURE ON 100 % ITEMS</td>
</tr>
<tr>
<td>31</td>
<td>Functional Tests</td>
<td>FOR 100 % ITEMS</td>
</tr>
</tbody>
</table>

**NOTE:**

1.) VENDOR TO PROVIDE ALL MATERIAL & OTHER TEST CERTIFICATES FOR PURCHASER’S REVIEW & RECORDS
2.) AIR LEAK TEST & FUNCTIONAL TEST SHALL BE DONE BEFORE & AFTER SEISMIC TEST WHEN SPECIFIED
3.) UNDER RELIEVING OPERATION, LEAKAGE FROM PRV SHALL NOT EXCEED 5 CC / MIN.

**7.8. General Specification for Instrument Air Filter:**

AIR FILTER DATA SHEET

<table>
<thead>
<tr>
<th>SL</th>
<th>DESCRIPTIONS</th>
<th>DATA</th>
</tr>
</thead>
</table>
1. SERVICE: INSTRUMENT AIR
2. TYPE: CARTRIDGE
3. HOUSING TYPE: F-FLANGED HOUSING
4. CARTRIDGE GRADE: GENERAL PURPOSE PROTECTION "GP"
5. DRAIN: MANUAL
6. FILTER AREA: 12 TIMES PIPE AREA
7. FILTER PERFORMANCE: 0.2 MICRON DUST PARTICLES, OIL
8. AIR FLOW @ 7 bar g: *cfm
9. DIFFERENTIAL PRESSURE GAUGE: REQUIRED
10. MOUNTING BRACKET: REQUIRED
11. HOUSING(BODY) MATERIAL: WELDED MILD STEEL VESSELS
12. FINISH: EPOXY PAINTED
13. CONDENSATE DRAIN: AUTOMATIC
14. FILTER MATERIAL: MACHINE PLEATED WITH GLASS MICROFIBRE
15. PACKING MATERIAL: TEFILON/BUNA N
16. INLET CONNECTION: DN 20 FLANGE TYPE
17. OUTLET CONNECTION: DN 20 FLANGE TYPE
18. BOWL LIQUID LEVEL GAUGE: YES
19. APPLICABLE CODES AND STDs: ISO 8573.1 QUALITY 2
20. MAXIMUM OPERATING PRESSURE: 16 bar g
21. MAX OPERATING TEMP °C: 66° C
22. MIN OPERATING TEMP °C: 1° C
23. DIMENSIONAL AND FLANGE CHECK: 100 % ITEMS
24. AIR FLOW AT 50 % CLOGGING: 90 % OF RATED FLOW
25. AUTO DRAIN FUNCTION CHECK: YES
26. FUNCTIONAL TESTS: FOR 100 % ITEMS

NOTE
1.) VENDOR TO PROVIDE ALL MATERIAL & OTHER TEST CERTIFICATES FOR PURCHASER'S REVIEW & RECORDS
2.) AIR FLOW TEST & FUNCTIONAL TEST SHALL BE DONE

Specification For Gas Monitor:

<table>
<thead>
<tr>
<th>General</th>
<th>1 Manufacturer</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Model No.</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3 Type</td>
<td>Microcontroller based Gas Monitor</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td><strong>Application</strong></td>
<td>To monitor Gas concentration in %LEL/PPM/%Vol.</td>
<td></td>
</tr>
<tr>
<td><strong>Dimensions</strong></td>
<td>250X91X91 mm (L X B X H)</td>
<td></td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Number of channels</strong></td>
<td>1/2/4/8 Channel Configurations</td>
<td></td>
</tr>
<tr>
<td><strong>Monitoring Range</strong></td>
<td>0-10/100/999 with Decimal selection</td>
<td></td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td>1/0.1 User programmable.</td>
<td></td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>± 1 % of FS ± 1 count</td>
<td></td>
</tr>
<tr>
<td><strong>Display Scan Rate</strong></td>
<td>3-sec/channel</td>
<td></td>
</tr>
<tr>
<td><strong>Input / Output Signal</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Analog Measurement</strong></td>
<td>4-20mA input for each channel</td>
<td></td>
</tr>
<tr>
<td><strong>Analog Supply</strong></td>
<td>24VDC for field Gas Detectors.</td>
<td></td>
</tr>
<tr>
<td><strong>Key's Control</strong></td>
<td>Increase, Right shift, Enter/ ACK, Reset</td>
<td></td>
</tr>
<tr>
<td><strong>Digital Dual Display</strong></td>
<td>Channel Number</td>
<td>One Digit - 7 Segment Red LED type</td>
</tr>
<tr>
<td><strong>Status Indication</strong></td>
<td>Visual Alarm</td>
<td>Gas Concentration</td>
</tr>
<tr>
<td><strong>Relay Contact</strong></td>
<td>External Operation</td>
<td>Alarm1 (Common)</td>
</tr>
<tr>
<td><strong>Audio Indication</strong></td>
<td>Audio Alarm</td>
<td>Alarm1</td>
</tr>
<tr>
<td><strong>Configuration/Programming mode</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Range Setting</strong></td>
<td>Monitoring range setting - with PASSWORD PROTECTION</td>
<td></td>
</tr>
<tr>
<td><strong>Calibration Setting</strong></td>
<td>Range Calibration</td>
<td></td>
</tr>
<tr>
<td><strong>Alarm Setting</strong></td>
<td>Default - Alarm 1 (20%) High type &amp; Alarm2(40%) High type</td>
<td></td>
</tr>
<tr>
<td><strong>Alarm Setting</strong></td>
<td>User settable- Alarm 1 (20%) Low type &amp; Alarm2(40%) High type</td>
<td></td>
</tr>
<tr>
<td><strong>Alarm Setting</strong></td>
<td>User settable- Alarm 1 (20%) Low type &amp; Alarm2(40%) Low type</td>
<td></td>
</tr>
<tr>
<td><strong>Skip Setting</strong></td>
<td>To skip un-installed channels</td>
<td></td>
</tr>
<tr>
<td><strong>Operating Supply Voltage</strong></td>
<td>110/230 VAC , 50 Hz. (24VDC optional)</td>
<td></td>
</tr>
<tr>
<td><strong>Ambient condition - Operating Temperature</strong></td>
<td>0 - 55 Degree C</td>
<td></td>
</tr>
<tr>
<td><strong>Ambient condition - Operating Humidity</strong></td>
<td>0 - 90% RH</td>
<td></td>
</tr>
<tr>
<td><strong>Environmental protection</strong></td>
<td>IP 42</td>
<td></td>
</tr>
<tr>
<td><strong>Enclosure material</strong></td>
<td>ABS Plastic, white</td>
<td></td>
</tr>
<tr>
<td><strong>Mounting of Enclosure</strong></td>
<td>Wall Mounting Type</td>
<td></td>
</tr>
<tr>
<td><strong>Cable Entry</strong></td>
<td>Suitable for four Gas Detectors. For additional</td>
<td></td>
</tr>
</tbody>
</table>
### Specification for Hydrogen Gas Detector:

<table>
<thead>
<tr>
<th></th>
<th>Manufacturer</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Model No.</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Part No.</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Application</td>
<td>Detection of HYDROGEN gas in hazardous area.</td>
</tr>
<tr>
<td>5</td>
<td>Dimensions</td>
<td>170 X 84.5 X 85 (L X B X H) mm</td>
</tr>
<tr>
<td>6</td>
<td>Weight</td>
<td>500 gm (max)</td>
</tr>
<tr>
<td>7</td>
<td>Sensor Type</td>
<td>Catalytic Bead</td>
</tr>
<tr>
<td>8</td>
<td>Detection Range</td>
<td>0-100% LEL</td>
</tr>
<tr>
<td>9</td>
<td>Accuracy</td>
<td>+/- 3%</td>
</tr>
<tr>
<td>10</td>
<td>Response Time T90</td>
<td>&lt;25 Sec.</td>
</tr>
<tr>
<td>11</td>
<td>Sensor Life</td>
<td>&gt;2 Years, Typically 5 Years.</td>
</tr>
<tr>
<td>12</td>
<td>Recommended Calibration Frequency</td>
<td>Maximum 6 Months between calibration</td>
</tr>
<tr>
<td>13</td>
<td>Sensor Housing Model</td>
<td>gaZsens SH</td>
</tr>
<tr>
<td>14</td>
<td>Sensor Housing Material</td>
<td>Stainless Steel - SS316L</td>
</tr>
<tr>
<td>15</td>
<td>Sensor Housing Certification</td>
<td>Ex d IIC T6 IP55 CIMFR TESTED &amp; PESO CERTIFIED WITH ISI MARK</td>
</tr>
<tr>
<td>16</td>
<td>Type</td>
<td>Three wire Conventional type</td>
</tr>
<tr>
<td>17</td>
<td>Standard Operating Voltage and Current</td>
<td>24Vdc @ 70mA.</td>
</tr>
<tr>
<td>18</td>
<td>Operating Voltage range</td>
<td>18 - 32 VDC</td>
</tr>
<tr>
<td>19</td>
<td>Inrush Current &amp; Power Consumption</td>
<td>125mA &amp; 3Watt at 24VDC</td>
</tr>
<tr>
<td>20</td>
<td>Ambient Condition - Operating Temperature</td>
<td>0 to 50 °C</td>
</tr>
<tr>
<td>21</td>
<td>Ambient Condition - Operating Humidity</td>
<td>93 +/- 3% (Max.)</td>
</tr>
<tr>
<td>22</td>
<td>Ambient Condition - Operating Pressure</td>
<td>Atmospheric</td>
</tr>
</tbody>
</table>
### Technical Specifications

<table>
<thead>
<tr>
<th>#</th>
<th>Specification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>Output Signals</td>
<td>Analog Measurement</td>
</tr>
<tr>
<td>24</td>
<td>Analog</td>
<td>Underrange fault</td>
</tr>
<tr>
<td>25</td>
<td>Analog</td>
<td>Overrange fault</td>
</tr>
<tr>
<td>26</td>
<td>Display *</td>
<td>Measurement</td>
</tr>
<tr>
<td>27</td>
<td>Relay Contact *</td>
<td>External Operation</td>
</tr>
<tr>
<td>28</td>
<td>Housing environmental protection</td>
<td>IP65</td>
</tr>
<tr>
<td>29</td>
<td>Hazardous Area protection</td>
<td>Exd IIC CIMFR/ERTL TESTED &amp; PESO CERTIFIED</td>
</tr>
<tr>
<td>30</td>
<td>Transmitter Enclosure Material</td>
<td>Epoxy coated, copper free Aluminium Die Cast</td>
</tr>
<tr>
<td>31</td>
<td>EMI/EMC</td>
<td>YES</td>
</tr>
<tr>
<td>32</td>
<td>Accessories</td>
<td>Part No.</td>
</tr>
<tr>
<td>33</td>
<td>Accessories</td>
<td>Part No.</td>
</tr>
<tr>
<td>34</td>
<td>Accessories</td>
<td>Part No.</td>
</tr>
<tr>
<td>35</td>
<td>Accessories</td>
<td>Part No.</td>
</tr>
<tr>
<td>36</td>
<td>Accessories</td>
<td>Part No.</td>
</tr>
<tr>
<td>37</td>
<td>Accessories</td>
<td>Part No.</td>
</tr>
<tr>
<td>38</td>
<td>Tests / Approvals</td>
<td>IS/IEC60079-1:2007</td>
</tr>
<tr>
<td>39</td>
<td>Sensor Housing Flameproof</td>
<td>IEC60079-11:1999</td>
</tr>
<tr>
<td>40</td>
<td>Transmitter Intrinsically safe</td>
<td>Test Report No.</td>
</tr>
<tr>
<td>41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>Sensor Housing Approval</td>
<td>Licence No.</td>
</tr>
<tr>
<td>44</td>
<td>Sensor Housing Approval</td>
<td>Approval No.</td>
</tr>
</tbody>
</table>

**Specification for Acetylene Gas Detector:**

<table>
<thead>
<tr>
<th>#</th>
<th>General</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Manufacturer</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Model No.</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Part No.</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Application</td>
<td>Detection of ACYTELENE gas in hazardous area.</td>
</tr>
<tr>
<td>5</td>
<td>Dimensions</td>
<td>170 X 84.5 X 85 (L X B X H) mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>6</td>
<td>Weight</td>
<td>500 gm (max)</td>
</tr>
<tr>
<td>7</td>
<td>Sensor Type</td>
<td>Catalytic Bead</td>
</tr>
<tr>
<td>8</td>
<td>Detection Range</td>
<td>0-100% LEL</td>
</tr>
<tr>
<td>9</td>
<td>Accuracy</td>
<td>+/- 3 %</td>
</tr>
<tr>
<td>10</td>
<td>Response Time T90</td>
<td>&lt;25 Sec.</td>
</tr>
<tr>
<td>11</td>
<td>Sensor Life</td>
<td>&gt;2 Years, Typically 5 Years.</td>
</tr>
<tr>
<td>12</td>
<td>Recommended Calibration Frequency</td>
<td>Maximum 6 Months between calibration</td>
</tr>
<tr>
<td>13</td>
<td>Sensor Housing Model</td>
<td>gaZsens SH</td>
</tr>
<tr>
<td>14</td>
<td>Sensor Housing Material</td>
<td>Stainless Steel - SS316L</td>
</tr>
<tr>
<td>15</td>
<td>Sensor Housing Certification</td>
<td>Ex d IIC T6 IP55 CIMFR TESTED &amp; PESO CERTIFIED WITH ISI MARK</td>
</tr>
<tr>
<td>16</td>
<td>Type</td>
<td>Three wire Conventional type</td>
</tr>
<tr>
<td>17</td>
<td>Standard Operating Voltage and Current</td>
<td>24Vdc @ 70mA.</td>
</tr>
<tr>
<td>18</td>
<td>Operating Voltage range</td>
<td>18 - 32 VDC</td>
</tr>
<tr>
<td>19</td>
<td>Inrush Current &amp; Power Consumption</td>
<td>125mA &amp; 3Watt at 24VDC</td>
</tr>
<tr>
<td>20</td>
<td>Ambient Condition - Operating Temperature</td>
<td>0 to 50 °C</td>
</tr>
<tr>
<td>21</td>
<td>Ambient Condition - Operating Humidity</td>
<td>93 +/- 3 % (Max.)</td>
</tr>
<tr>
<td>22</td>
<td>Ambient Condition - Operating Pressure</td>
<td>Atmospheric</td>
</tr>
<tr>
<td>23</td>
<td>Output Signals</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Analog</td>
<td>Measurement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4-20 mA. Source type( Non Isolated ), Max. load 600 Ohms</td>
</tr>
<tr>
<td>25</td>
<td>Analog</td>
<td>Underrange - fault</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt; 4 mA.</td>
</tr>
<tr>
<td>26</td>
<td>Analog</td>
<td>Overrange - fault</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;20 mA.</td>
</tr>
<tr>
<td>27</td>
<td>Display *</td>
<td>Measurement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>28</td>
<td>Relay Contact *</td>
<td>External Operation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>29</td>
<td>Housing environmental protection</td>
<td>IP65</td>
</tr>
<tr>
<td>30</td>
<td>Hazardous Area protection</td>
<td>Exd IIC CIMFR/ERTL TESTED &amp; PESO CERTIFIED</td>
</tr>
<tr>
<td>31</td>
<td>Transmitter Enclosure Material</td>
<td>Epoxy coated, copper free Aluminium Die Cast</td>
</tr>
<tr>
<td>32</td>
<td>EMI/EMC</td>
<td>YES</td>
</tr>
<tr>
<td>33</td>
<td>Accessories</td>
<td>Part No.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Calibration Adaptor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>REQUIRED</td>
</tr>
<tr>
<td>34</td>
<td>Accessories</td>
<td>Part No.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pipe Mount Kit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>35</td>
<td>Accessories</td>
<td>Part No.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Floor Mount Kit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>36</td>
<td>Accessories</td>
<td>Part No.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wall Mount Kit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>37</td>
<td>Accessories</td>
<td>Part No.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Splashguard</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>38</td>
<td>Accessories</td>
<td>Part No.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cable Gland</td>
</tr>
<tr>
<td></td>
<td></td>
<td>REQUIRED</td>
</tr>
</tbody>
</table>
### Tests / Approvals

<table>
<thead>
<tr>
<th>Test / Approval</th>
<th>Description</th>
<th>Standard / Certification</th>
<th>Manufacturer / Certification</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>Sensor Housing - Flameproof</td>
<td>IS/IEC60079-1:2007</td>
<td>CIMFR, Dhanbad</td>
<td>YES</td>
</tr>
<tr>
<td>40</td>
<td>Transmitter - Intrinsically safe</td>
<td>IEC60079-11:1999</td>
<td>CIMFR, Dhanbad</td>
<td>YES</td>
</tr>
<tr>
<td>41</td>
<td>Transmitter - Performance</td>
<td>Test Report No. ERTL(W)-Mumbai</td>
<td></td>
<td>YES</td>
</tr>
<tr>
<td>42</td>
<td>Transmitter - EMI/EMC</td>
<td>IEC61326-1:2005</td>
<td>ERTL(W)-Mumbai</td>
<td>YES</td>
</tr>
<tr>
<td>43</td>
<td>Sensor Housing - Approval</td>
<td>Licence No. BIS, Mumbai</td>
<td></td>
<td>YES</td>
</tr>
<tr>
<td>44</td>
<td>Sensor Housing - Approval</td>
<td>Approval No. PESO, NAGPUR</td>
<td></td>
<td>YES</td>
</tr>
</tbody>
</table>

### Specification for LPG Gas Detector:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General</strong></td>
<td></td>
</tr>
<tr>
<td>1 Manufacturer</td>
<td>-</td>
</tr>
<tr>
<td>2 Model No.</td>
<td>-</td>
</tr>
<tr>
<td>3 Part No.</td>
<td>-</td>
</tr>
<tr>
<td>4 Application</td>
<td>Detection of LPG in hazardous area.</td>
</tr>
<tr>
<td>5 Dimensions</td>
<td>170 X 84.5 X 85 (L X B X H) mm</td>
</tr>
<tr>
<td>6 Weight</td>
<td>500 gm (max)</td>
</tr>
<tr>
<td><strong>Sensor</strong></td>
<td></td>
</tr>
<tr>
<td>7 Sensor Type</td>
<td>Catalytic Bead</td>
</tr>
<tr>
<td>8 Detection Range</td>
<td>0-100% LEL</td>
</tr>
<tr>
<td>9 Accuracy</td>
<td>+/- 3 %</td>
</tr>
<tr>
<td>10 Response Time T90</td>
<td>&lt;25 Sec.</td>
</tr>
<tr>
<td>11 Sensor Life</td>
<td>&gt;2 Years, Typically 5 Years.</td>
</tr>
<tr>
<td>12 Recommended Calibration Frequency</td>
<td>Maximum 6 Months between calibration</td>
</tr>
<tr>
<td>13 Sensor Housing Model</td>
<td>-</td>
</tr>
<tr>
<td>14 Sensor Housing Material</td>
<td>Stainless Steel - SS316L</td>
</tr>
<tr>
<td>15 Sensor Housing Certification</td>
<td>Ex d IIC T6 IP55 CIMFR TESTED &amp; PESO CERTIFIED WITH ISI MARK</td>
</tr>
<tr>
<td><strong>Transmitter</strong></td>
<td></td>
</tr>
<tr>
<td>16 Type</td>
<td>Three wire Conventional type</td>
</tr>
<tr>
<td>17 Standard Operating Voltage and Current</td>
<td>24Vdc @ 70mA.</td>
</tr>
<tr>
<td>18 Operating Voltage range</td>
<td>18 - 32 VDC</td>
</tr>
<tr>
<td>19 Inrush Current &amp; Power Consumption</td>
<td>125mA &amp; 3Watt at 24VDC</td>
</tr>
<tr>
<td>20 Ambient Condition - Operating Temperature</td>
<td>0 to 50 °C</td>
</tr>
<tr>
<td>21 Ambient Condition - Operating Humidity</td>
<td>93 +/- 3 % (Max.)</td>
</tr>
<tr>
<td>22 Ambient Condition - Operating</td>
<td>Atmospheric</td>
</tr>
</tbody>
</table>
### TECHNICAL SPECIFICATIONS - VACUUM PIPING SYSTEM

#### 7.1. Scope:

**7.1.1. Design of Vacuum Piping.**

The scope of work shall cover supply, storage at site, transportation to the place of erection, fabrication/assembly, laying/erection, painting, testing and commissioning of the industrial tubing & piping system for VACUUM for the project as a whole with necessary supports and supporting structures.

#### 7.2. Design Criteria:

**7.2.1. Vacuum:**

- Laboratory has VACUUM requirement.
• Distribution of Vacuum is planned to draw from Vacuum Generator Plant by 40 NB dia pipes.
• The supply of Vacuum will be safely, suitably regulated and to required user points.
• MOC of pipes shall GI upto the external area of cleanroom and shall be SS316 (L) inside the cleanroom
• All joint of pipes & valves shall be socket weld, except user point 15NB dia valves, filter and pressure regulator (screwed end).
• Vacuum filter and pressure Regulator at the inlet of lab. There is no addition regulator required in lab of room wise/ user point wise.
• Tapping for user points at inside the laboratory with individual 1/2”& 1/4” OD tapping from main header. Branch wise or user point tapping shall have an isolation valves or bench mounted valves.

7.3. Codes & Standards:
All piping works covered under this specification shall comply with currently applicable statutes, regulations and safety codes. They shall comply in all respects with the requirements of the latest editions of the codes and standards. In case of conflict between codes and standards referred to in this specification or documents enclosed with specification.
Important relevant IS Codes for this Specification are listed below:

7.3.1. Steel Pipes, Tubes & Fittings Codes & Standards
• American Society for Testing and Materials (ASTM)
  ➢ A269 Seamless and Welded Austenitic Stainless Steel Tubing for General Service TP 316
  ➢ A370 Standard Methods and Definitions for Mechanical Testing of Steel Products
  ➢ A632 Seamless and Welded Austenitic Stainless Steel Tubing (Small Diameter) for General Service
• American National Standards Institute (ANSI)
  ➢ B31.1 Code for Pressure Piping, Chemical Plant and Petroleum Refinery Piping
  ➢ B31.3 Process Piping
• IS: 1239 – 1990 : M.S. Tubes, Tubular & Part-I other wrought steel fittings.
• IS: 3589 – 2001 : Seamless (or) electrically welded steel pipes for Water, gas& sewage.
• IS: 5504 - 1997 : Spiral welded pipes.
• IS: 1239 (Part-2) : M.S. Tubes, tubular and (1992) wrought Steel fittings.)
• IS: 11428-1985 : Wrought carbon steel butt (Part 1 to 3)
• American Society of Mechanical Engineers (ASME)
  Section IX Welding Qualification
• Welding Procedure/Qualification: ASME B 31.3/31.8, ASME Sec IX & IS: 817
- ASME Sec IX & IS: 814: Material Specifications, Welding rods, Electrodes & filler wire etc.
- ANSI-B-16.5: Pipe Flanges & Flanged Fittings
- ASME/ANSI-B-16.10: Face-to-Face & End-to-End Dimensions of Valves
- ANSI-B-18.2.1: Square & Hex Bolts & Screw.
- IS Standard or Equivalent: Gauges
### CONSTRUCTION OF DRUG TESTING LABORATORY AT KATHUA, J&K

#### List of Approved Makes of Materials

1. **List of Approved Makes - Civil & Interior Services**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Details of Equipment / Material</th>
<th>Make/manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Acoustical False Ceiling / Panelling</td>
<td>Ecotone / Armstrong / Anutone</td>
</tr>
<tr>
<td>2.</td>
<td>Admixture</td>
<td>Fosroc / SIKKA / Choksey / BASF</td>
</tr>
<tr>
<td>3.</td>
<td>Adhesive for Wood Work</td>
<td>Fevicol / Vamicol / Dunlop</td>
</tr>
<tr>
<td>4.</td>
<td>Aluminium Accessories and Hardware</td>
<td>Classic / Crown / EBCO / Earl Bihari</td>
</tr>
<tr>
<td>5.</td>
<td>Aluminium composite panels</td>
<td>Alucobond / Alstone/Reynobond</td>
</tr>
<tr>
<td>6.</td>
<td>Aluminium Die-Cast handles &amp; two point locking kit</td>
<td>Giesse / Securistyle / Alu – alpha</td>
</tr>
<tr>
<td>7.</td>
<td>Aluminium Extrusion</td>
<td>Hindalco / Jindal / Indal</td>
</tr>
<tr>
<td>8.</td>
<td>Aluminium Fabricator</td>
<td>To be approved by the Engineer-in-Charge</td>
</tr>
<tr>
<td>9.</td>
<td>Anchor / Dash Fastener</td>
<td>Hilti / Faisher/Bosch</td>
</tr>
<tr>
<td>10.</td>
<td>Anti – Termite Treatment</td>
<td>It should be done by permanent members of IPCA as approved by Engineer-in-Charge.</td>
</tr>
<tr>
<td>11.</td>
<td>Automatic Censored Operated Sliding Doors / Panels</td>
<td>Dorma Kaba / Geze</td>
</tr>
<tr>
<td>12.</td>
<td>Ready Mix Concrete (RMC)</td>
<td>The RMC shall be procured from the source as approved by Engineer – in Charge.</td>
</tr>
<tr>
<td>13.</td>
<td>Cement</td>
<td>Ultra Tech / JK Cement / Ambuja / Lafarge</td>
</tr>
<tr>
<td>15.</td>
<td>Ceramic Tiles Adhesive</td>
<td>Cico / Pidilite / SIKKA / Laticrete</td>
</tr>
<tr>
<td>16.</td>
<td>Clean Room Wall Panels with/without return air risers, Doors/ windows etc.</td>
<td>CLESTRA/ NICOMAC / HEMAIR / GMP / EPACK</td>
</tr>
<tr>
<td>17.</td>
<td>Clear Glass / Clear Float Glass / Toughened Glass</td>
<td>Modi / Saint Gobain (SG) / Asahi India Safety Glass Ltd</td>
</tr>
<tr>
<td>18.</td>
<td>Compressed Chequered tiles</td>
<td>Kajaria / Nitco / Johnson</td>
</tr>
<tr>
<td>19.</td>
<td>Concrete Additive</td>
<td>SIKKA /CICO/Pidilite / Fosroc / Fairmate</td>
</tr>
<tr>
<td>20.</td>
<td>Curtain Rod / Drapery Rod / Venetian Blinds</td>
<td>Vista work / Mac Décor or equivalent</td>
</tr>
<tr>
<td>21.</td>
<td>Cover / Spacer Block</td>
<td>Convextra as manufactured by M/s Fosroc chemical India Ltd or equivalent.</td>
</tr>
<tr>
<td>22.</td>
<td>Disc Filter</td>
<td>Azud / Spain/ Amaid / Arkal /</td>
</tr>
<tr>
<td>23.</td>
<td>Door closer / Floor spring</td>
<td>Godrej / Doorking / Everite / Hardwyn / Dormakaba/Geze</td>
</tr>
<tr>
<td>24.</td>
<td>Door Locks</td>
<td>Godrej / Harrison / Link / Dormakaba</td>
</tr>
<tr>
<td>25.</td>
<td>Door Seal – Wool pile Weather Strip</td>
<td>Anand Reddioplex / Enviroseal</td>
</tr>
<tr>
<td>No.</td>
<td>Fitting</td>
<td>Supplier</td>
</tr>
<tr>
<td>------</td>
<td>-------------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>27.</td>
<td>E.P.D.M Gaskets</td>
<td>Anand Reddiplex / Enviro Seals</td>
</tr>
<tr>
<td>28.</td>
<td>Epoxy Flooring</td>
<td>Fosroc / SIKKA / Flamaflor / Dr Beck</td>
</tr>
<tr>
<td>29.</td>
<td>Epoxy SLF Flooring</td>
<td>SIKKA / BASF / Pidilite</td>
</tr>
<tr>
<td>30.</td>
<td>Expansion joint</td>
<td>Migua / 3r joints and seals / PD projects</td>
</tr>
<tr>
<td>31.</td>
<td>Extruded Polystyrene Board</td>
<td>Styrofoam by DOW Chemical / Insusboard by Supreme Industries</td>
</tr>
<tr>
<td>32.</td>
<td>False Ceiling - Gypsum- Boards &amp; Tiles</td>
<td>India Gypsum / Armstrong / Aerolite / Saint Gobain (Gyproc) / Grid Square</td>
</tr>
<tr>
<td>33.</td>
<td>False Ceiling - Metal</td>
<td>Armstrong / Unimet / Hunter Douglas / Saint Gobain / Grid Square / USG Boral</td>
</tr>
<tr>
<td>34.</td>
<td>False Ceiling - Mineral Fibre</td>
<td>Armstrong / Decosonic / AMF / Saint Gobain (Gyproc) / Grid square / USG Boral / Dexeun</td>
</tr>
<tr>
<td>35.</td>
<td>Fire rated Doors &amp; Frames</td>
<td>Navair / Godrej / Sukriti</td>
</tr>
<tr>
<td>36.</td>
<td>Fire Rated Glass</td>
<td>Asahi India Safety Glass Ltd. / Modi / Saint Gobin / Pyroguard / SCHO'TT</td>
</tr>
<tr>
<td>37.</td>
<td>Fire Retardant Paint</td>
<td>Viper FRS 881 / Nullifire / Burger</td>
</tr>
<tr>
<td>38.</td>
<td>Fire Seal</td>
<td>Sealz / Alstroflam / Abacus</td>
</tr>
<tr>
<td>40.</td>
<td>Fire: D-Type Pull Handles</td>
<td>Dorma / Godrej / Hardwyin</td>
</tr>
<tr>
<td>42.</td>
<td>Fire: Panic Exit Devices</td>
<td>Inersoll Rand / Dorma / Godrej / D-line</td>
</tr>
<tr>
<td>43.</td>
<td>Fire: Tower Bolts</td>
<td>Suzu / Nulite / Dorset / Dorma / Godrej</td>
</tr>
<tr>
<td>44.</td>
<td>Flush Door Shutters</td>
<td>Duro / Greenply / Century / Merino</td>
</tr>
<tr>
<td>45.</td>
<td>Floor Hardener</td>
<td>Pidilite / SIKKA / BASF / Firmate</td>
</tr>
<tr>
<td>46.</td>
<td>Glass : Mirror &amp; Float</td>
<td>Modiguard / Atul / Saint Gobain / Asahi India Safety / Modi Glass</td>
</tr>
<tr>
<td>47.</td>
<td>Glass for Aluminium Doors/ Windows/ Structural Glazing</td>
<td>Modiguard / Saint Gobain / Pilkington / Asahi India Safety Glass Ltd. / Modi Glass</td>
</tr>
<tr>
<td>48.</td>
<td>Glass Wool / Insulation Boards</td>
<td>Rockwool / UP Twiga / Lloyd Insulation / Pidilite</td>
</tr>
<tr>
<td>49.</td>
<td>Grout: Non Shrink</td>
<td>FOSROC / SIKKA / POLIDITE</td>
</tr>
<tr>
<td>50.</td>
<td>Grouting Compound</td>
<td>Bal Endura / Pidilite / Laticrete / Unitile</td>
</tr>
<tr>
<td>51.</td>
<td>Heat Resistant Terrace Tiles</td>
<td>Thermatek or equivalent</td>
</tr>
<tr>
<td>52.</td>
<td>High Pressure Laminate (HPL)</td>
<td>Abet / Trespa / Fundermax</td>
</tr>
<tr>
<td>53.</td>
<td>Laminates / Veneers</td>
<td>Century / Greenlam / Formica / Sunmica / Merrino / Archidply</td>
</tr>
<tr>
<td>54.</td>
<td>Logo, Signage, Name Plate</td>
<td>D-line / Sign Sutra / Sameer</td>
</tr>
<tr>
<td>55.</td>
<td>Melamine</td>
<td>ICI Dulux / Timberstone Melamine Coating</td>
</tr>
<tr>
<td>56.</td>
<td>Night Latch</td>
<td>Godrej / Dorma / Geze / Haflé</td>
</tr>
<tr>
<td>57.</td>
<td>Paints- Anti fungal</td>
<td>Sikka by Liquid Plastic / VIESMANN / SSK / Trilux</td>
</tr>
<tr>
<td>58.</td>
<td>Paints - Cement Based</td>
<td>Snowcem Plus / Berger (Durocem Extra) / Nerolac (Super Acrylic) / TATA Cem</td>
</tr>
<tr>
<td>59.</td>
<td>Paints - Epoxy paint</td>
<td>Nerolac / Cico / SIKKA / BASF / Berger</td>
</tr>
<tr>
<td>No.</td>
<td>Material Type</td>
<td>Brands/Models</td>
</tr>
<tr>
<td>-----</td>
<td>---------------------------------------------------</td>
<td>----------------------------------------------------</td>
</tr>
<tr>
<td>60</td>
<td>Paints - Oil Bound Distemper / Acrylic Washable Distemper</td>
<td>Pidilite / ICI Dulux</td>
</tr>
<tr>
<td>61</td>
<td>Paints - Other Paints / Primer</td>
<td>ICI Dulux / Asian / Berger / Nerolac / Acro</td>
</tr>
<tr>
<td>62</td>
<td>Paints - Plastic Emulsion Paint</td>
<td>ICI Dulux / Asian / Berger / Nerolac / Acro</td>
</tr>
<tr>
<td>63</td>
<td>Paints - Synthetic Enamel Paints</td>
<td>ICI Dulux (Gloss) / Berger (Luxol Gold) / Acro / Goodlas Nerolac (Full gloss hard drying)</td>
</tr>
<tr>
<td>64</td>
<td>Paints - Texture paint</td>
<td>Berger / Spectrum / Unilite Heritage / Asian / Acro</td>
</tr>
<tr>
<td>65</td>
<td>Patch fittings</td>
<td>Dorma / Ozone / Geze</td>
</tr>
<tr>
<td>66</td>
<td>Paver blocks (All Types)</td>
<td>UniStone Products (India) Pvt. Ltd / Hindustan Tiles / NITCO / NTC</td>
</tr>
<tr>
<td>67</td>
<td>Plywood / Block Board / Ply Board</td>
<td>Duro / Greenply / Century / Kiptply / Greenply / Corbet / Anchor / Merino</td>
</tr>
<tr>
<td>68</td>
<td>Polycarbonate Sheets</td>
<td>Danaplon India / Polygal / Makrolan / Gallina / Tuflite</td>
</tr>
<tr>
<td>69</td>
<td>Poly - Sulphide Sealant</td>
<td>Pidilite / Fosroc / Cico / SIKKA</td>
</tr>
<tr>
<td>70</td>
<td>Powder Coating Material pure Polyester</td>
<td>Jotun / Berger / Goodlass Nerolac / Acro</td>
</tr>
<tr>
<td>71</td>
<td>Pre-coated Galvanized Steel Sheet</td>
<td>Tata BlueScope / Llyod Insulations India Ltd / S.R. Metals / Jindals</td>
</tr>
<tr>
<td>72</td>
<td>Pre-Laminated Particle Board</td>
<td>Novapan / Century / Green Ply / Merino</td>
</tr>
<tr>
<td>73</td>
<td>PVC Doors</td>
<td>Sintex / Polyex / Rajshri / Alstone</td>
</tr>
<tr>
<td>74</td>
<td>PVC Flooring</td>
<td>Tarkett Floors / LG Floors / Gerflor / Premier Vinyl flooring / Regent / Armstrong</td>
</tr>
<tr>
<td>75</td>
<td>PVC Continuous Fillet for periphery packing of Glazing / Structural / Glazing</td>
<td>Roop / Anand / Forex Plastic / Nagalia / Trading Company</td>
</tr>
<tr>
<td>76</td>
<td>Raise / False Access</td>
<td>Unite / Unifloor / Tale</td>
</tr>
<tr>
<td>77</td>
<td>Reinforcement Steel</td>
<td>SAIL / RINL / TATA Steel Ltd. / Jindal Steel &amp; Power Ltd. / RMCOM Steel / JSW Steel Ltd.</td>
</tr>
<tr>
<td>78</td>
<td>Rest room Cubicles</td>
<td>Merino / Greenlam / Fundermax</td>
</tr>
<tr>
<td>79</td>
<td>Sealant : Poly sulphide</td>
<td>Pidilite / Fosroc / CICO / Sikka</td>
</tr>
<tr>
<td>80</td>
<td>SFRC / RCC Manhole Covers/ Perfect RCC Grating</td>
<td>KK Manholes / SK Precast Concrete / Advent concreteovision / Daya concrete</td>
</tr>
<tr>
<td>81</td>
<td>Silicon sealants /Weather Sealant / Structural Glazing Sealant</td>
<td>GE- Silicon / Pidilite / Forsoc / Cico / Dow Corning / SIKKA / Wecker</td>
</tr>
<tr>
<td>82</td>
<td>Stainless Steel</td>
<td>Salem Steel / Jindal or equivalent</td>
</tr>
<tr>
<td>83</td>
<td>Stainless Steel bolts, Washers &amp; Nuts</td>
<td>Kundan / Puja / Atul</td>
</tr>
<tr>
<td>84</td>
<td>Stainless Steel Clamps</td>
<td>Hilti / Intellotech Koncept or equivalent</td>
</tr>
<tr>
<td>85</td>
<td>Stainless Steel D-handles</td>
<td>D Line / Geze / Dormakaba</td>
</tr>
<tr>
<td>86</td>
<td>Stainless Steel Friction Stay</td>
<td>Earl Bihari / Securistyle / EBCO</td>
</tr>
</tbody>
</table>
### 2. List of Approved Makes - Plumbing

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Details of Equipment / Material</th>
<th>Manufacturer/ Supplier/ Make</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Automatic variable temperature control / fixed temperature control</td>
<td>Jaquar / AOS-Robo-U-Tec/ Parry / Angash / Euronics</td>
</tr>
<tr>
<td></td>
<td>faucets</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Butterfly Valve (Lever type)</td>
<td>AUDCO /Advance/Atam/Sant/Zoloto/Danfoss</td>
</tr>
<tr>
<td>3.</td>
<td>Butterfly Valve (Gear type)</td>
<td>AUDCO /Advance/Atam/Sant/Zoloto/NVR</td>
</tr>
<tr>
<td>4.</td>
<td>Central Control</td>
<td>Rain Bird, USA/Toro/Nelson</td>
</tr>
<tr>
<td>5.</td>
<td>Centrifugally C.I Rainwater Intel fitting, Bronze gratings</td>
<td>NECO/BIC</td>
</tr>
<tr>
<td>7.</td>
<td>Chlorinator</td>
<td>Thermax Ltd/ Watcon, Ion exchange/ Sigma DH Combine Inc./ Siemens/</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Techcon/Jesco / Prominent Heidelberg</td>
</tr>
<tr>
<td>8.</td>
<td>Chlorine Dosing System</td>
<td>Toshcon / Chloromax</td>
</tr>
<tr>
<td>9.</td>
<td>Cockroach Trap</td>
<td>Chilly/ Player/ Camry</td>
</tr>
<tr>
<td>10.</td>
<td>Copper Fittings (Capillary)</td>
<td>Yorkshire Imperial, U.K./ Rajco Metal Works Mumbai / IBP Conex Ltd.</td>
</tr>
<tr>
<td></td>
<td>Item Description</td>
<td>Supplier/Brand</td>
</tr>
<tr>
<td>---</td>
<td>-------------------------------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>11.</td>
<td>Chromium plated/ stainsteel/polyvinyl chloride grating</td>
<td>Jaquar/ Kingston</td>
</tr>
<tr>
<td>12.</td>
<td>C.I Y type Strainer valve</td>
<td>Leader/Emrald/Kirloskar</td>
</tr>
<tr>
<td>13.</td>
<td>C.I Double Acting Air valve</td>
<td>Leader/Emrald/Kirloskar</td>
</tr>
<tr>
<td>14.</td>
<td>Disc Filter</td>
<td>Azud / Spain / Amaid / Arkal</td>
</tr>
<tr>
<td>15.</td>
<td>Ductile Iron Fittings (IS:9523)</td>
<td>Electrosteel/Kesoram/Tisco/Jindal</td>
</tr>
<tr>
<td>17.</td>
<td>E.P.D.M Gaskets</td>
<td>Anand Reddiplex / Enviro Seals / HANU</td>
</tr>
<tr>
<td>18.</td>
<td>Electrical hot water</td>
<td>Venus / Kingston</td>
</tr>
<tr>
<td>19.</td>
<td>Foot Valve</td>
<td>Zoloto/leader/kirloskar</td>
</tr>
<tr>
<td>20.</td>
<td>Filter and softner</td>
<td>Thermax / Watcon/ Bhartiya Techno Craft/Migrani</td>
</tr>
<tr>
<td>21.</td>
<td>Forged Steel Fittings &amp; Flanges (For Welded joints)</td>
<td>Rohini / Kanwal/ Vijay Cycle &amp; Steel (VS)</td>
</tr>
<tr>
<td>22.</td>
<td>Geyser</td>
<td>Spherehot / Racold / Usha Lexus /Bajaj</td>
</tr>
<tr>
<td>23.</td>
<td>Hand Drier</td>
<td>Kopal / Utech Systems / Euronics Automat</td>
</tr>
<tr>
<td>24.</td>
<td>HDPE Pipes / Moulded Fittings</td>
<td>Emco / Polyefins/Pioneer Plyfab/ Jain</td>
</tr>
<tr>
<td>25.</td>
<td>HDPE Solution tank</td>
<td>Watcon / Ion Exchange / Water Supply Specialist Pvt. Ltd.</td>
</tr>
<tr>
<td>26.</td>
<td>Inbuilt Drip Line</td>
<td>Azud/ Rainbrid-USA/ Netafim</td>
</tr>
<tr>
<td>27.</td>
<td>Irrigation pump</td>
<td>Armstrong/ Groundfos/kirloskar/Crompton</td>
</tr>
<tr>
<td>28.</td>
<td>Insulation of Hot water pipes</td>
<td>Vidoflex insulation / Superion insulation Kaiflex – Kaimann/Armoflex/Thermaflex</td>
</tr>
<tr>
<td>30.</td>
<td>Liquid Soap Dispenser</td>
<td>Euronics/Utec/Kopal</td>
</tr>
<tr>
<td>31.</td>
<td>Motorized Valve</td>
<td>Danfoss/ Honeywell</td>
</tr>
<tr>
<td>32.</td>
<td>MS Saddle with G.I. Riser</td>
<td>Harvel/ Alprene/Rain Bird, USA</td>
</tr>
<tr>
<td>33.</td>
<td>PVC flushing cistern</td>
<td>Commander / Parryware / Hindware/ Cera</td>
</tr>
<tr>
<td>34.</td>
<td>P.R.S. Dials</td>
<td>Rain Bird, USA/ Toro, USA/ Nelson,</td>
</tr>
<tr>
<td>35.</td>
<td>P.T.M.T. Fitting</td>
<td>Prince India / Symet/Prayag/ Polytuf</td>
</tr>
<tr>
<td>36.</td>
<td>Pipe coat material (pipe protection)</td>
<td>RPG Raychem/Pypkote/Makphalt/Lwl</td>
</tr>
<tr>
<td>38.</td>
<td>Pipe: - G.I.</td>
<td>Jindal / Tata / Prakash Surya/SAIL/Swastik</td>
</tr>
<tr>
<td>39.</td>
<td>Pipes &amp; fitting: PVC for SWR Soil, Waste &amp; Vent Pipes and fittings, Type B PVC Casing &amp; Screen Pipes</td>
<td>Prince / Supreme / Finolex</td>
</tr>
<tr>
<td></td>
<td>Item Description</td>
<td>Brand(s)</td>
</tr>
<tr>
<td>---</td>
<td>-------------------------------------------</td>
<td>-----------------------------------------</td>
</tr>
<tr>
<td>40.</td>
<td>Pipes &amp; Fittings: CPVC</td>
<td>Flowguard/ Astral/ Ashrivad/ Supreme/ AKG</td>
</tr>
<tr>
<td>41.</td>
<td>Pipes &amp; fittings: UPVC</td>
<td>Finolex / Prince / Supreme / AKG / Kasta / Vector / Astral</td>
</tr>
<tr>
<td>42.</td>
<td>Pipes &amp; Gully Trap: Stone ware</td>
<td>Perfect / S.K.F/ R.K/ Hind / Anand</td>
</tr>
<tr>
<td>43.</td>
<td>Pipes and Accessories: PE-AL-PE</td>
<td>Kitec/ Jindal/ Kissan/Vista</td>
</tr>
<tr>
<td>44.</td>
<td>Pipes: Copper</td>
<td>Rajco Metal works, Mumbai / IBP Conex Ltd.</td>
</tr>
<tr>
<td>45.</td>
<td>Pipes: M.S.</td>
<td>Jindal / Prakash – Surya /TATA</td>
</tr>
<tr>
<td>46.</td>
<td>Pipes: PP-R (PN – 16)</td>
<td>Amitex Polymers Pvt. Ltd. / Prince/ Supreme</td>
</tr>
<tr>
<td>47.</td>
<td>Pipes: R.C.C</td>
<td>Indian Hume Pipe / Pragati Concrete Udyog Daya/ KK / JSP</td>
</tr>
<tr>
<td>48.</td>
<td>Plastic seat cover of W.C</td>
<td>Commander/Hindware / Parryware</td>
</tr>
<tr>
<td>49.</td>
<td>Polyethylene Storage Tank</td>
<td>Sintex / Polycon/ Fusion/ Biplast</td>
</tr>
<tr>
<td>50.</td>
<td>Pop up Connecting Assembly</td>
<td>Rain Bird/Dura/Lasco</td>
</tr>
<tr>
<td>51.</td>
<td>Popup Spray Head</td>
<td>Rain Bird/Toro, USA/Nelson</td>
</tr>
<tr>
<td>52.</td>
<td>Powder Coating Material pure Polyester</td>
<td>Jotun / Berger / Goodlass Nerolac</td>
</tr>
<tr>
<td>53.</td>
<td>PVC Water Stops</td>
<td>Prince /Supreme/ Finolex</td>
</tr>
<tr>
<td>54.</td>
<td>RQRC Hydrant</td>
<td>Harvel/Alprene/Rain Bird, USA</td>
</tr>
<tr>
<td>55.</td>
<td>RQRC Key</td>
<td>Harvel/ Aqua/ Drip&amp;Drip</td>
</tr>
<tr>
<td>57.</td>
<td>SS Gratings/ Soap Dish/Towel Rail etc.</td>
<td>Camry/Glacier/Gem/ Jaquar/ Grohe</td>
</tr>
<tr>
<td>58.</td>
<td>Solar hot water heater</td>
<td>TATA Solar/Solahart</td>
</tr>
<tr>
<td>59.</td>
<td>Electrical panel</td>
<td>SPC Electrotech / Adlec/ Havells/C &amp; S / ABB</td>
</tr>
<tr>
<td>60.</td>
<td>Stainless Steel Sink</td>
<td>Hindware / Neelkanth / Nirali / Jayna</td>
</tr>
<tr>
<td>61.</td>
<td>Sounder pattern valve for filter and softener</td>
<td>Labline/AIP (Agriculture and Industrial pumps).</td>
</tr>
<tr>
<td>62.</td>
<td>Storage Type Heater</td>
<td>Venus/Racold/ Cromptonor</td>
</tr>
<tr>
<td>63.</td>
<td>Sump pump</td>
<td>Groundfos/kirloskar/Crompton/KSB</td>
</tr>
<tr>
<td>64.</td>
<td>Towel ring, Towel Rod, Towel, Towel rack, coat hook, etc (304 grade S.S)</td>
<td>Jaquar/ Kingston/Grohe</td>
</tr>
<tr>
<td>65.</td>
<td>Valve Box</td>
<td>Rain Bird, USA/Carson Brook, USA/Dura,</td>
</tr>
<tr>
<td>66.</td>
<td>Valve: Air Release</td>
<td>Azud/ API/ Bermad/ BIR/ Kirloskar / Venus / Zoloto</td>
</tr>
<tr>
<td>67.</td>
<td>Valve: Butterfly</td>
<td>Zolato/Audco /Sant/ KSB</td>
</tr>
<tr>
<td>No.</td>
<td>Item</td>
<td>Manufacturer</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td>68</td>
<td>Valve: Gun metal</td>
<td>Kilburn / Leader / Zoloto / Sant / Kartar / AIP / Audco</td>
</tr>
<tr>
<td>69</td>
<td>Valve: Flush</td>
<td>Gem / Jaquar / Marc / Kerovit / ESSEL</td>
</tr>
<tr>
<td>70</td>
<td>Valve: Mainline Isolation</td>
<td>Sant / Leader / Zoloto,</td>
</tr>
<tr>
<td>71</td>
<td>Valve: Pressure Relief</td>
<td>Sant / Leader / Zolato / Audco</td>
</tr>
<tr>
<td>72</td>
<td>Valve: Sluice / NRV</td>
<td>Kirloskar / IVC / Kilburn / Zoloto / Castle / Leader / L&amp;T / Audco</td>
</tr>
<tr>
<td>73</td>
<td>Valve: Solenoid</td>
<td>Rain Bird, USA / Toro / Nelson,</td>
</tr>
<tr>
<td>74</td>
<td>Valve: Non Return</td>
<td>Sant / Leader / Zoloto / AIP / Kirloskar / IVC / Leader / Audco</td>
</tr>
<tr>
<td>75</td>
<td>Valves: Gunmetal / C.P brass angle</td>
<td>Zoloto / Leader / Kilburn / Sant / Kartar / AIP / Audco</td>
</tr>
<tr>
<td>76</td>
<td>VFD Pump</td>
<td>Jyoti / Crompton / Kirloskar / KSB / Grundfos / Mather &amp; Platt</td>
</tr>
<tr>
<td>77</td>
<td>Vibration Eliminator Resisto-flex Pads &amp; Connections</td>
<td>Relay Corp./ Kanwal</td>
</tr>
<tr>
<td>78</td>
<td>Vitreous China Sanitary wares</td>
<td>Hindware / Cera / Toto / Kerovit</td>
</tr>
<tr>
<td>79</td>
<td>Water Cooler</td>
<td>Blue Star / Voltas / Usha / Godrej</td>
</tr>
<tr>
<td>80</td>
<td>Water Meter</td>
<td>Capstan / Kranti / Anand / Kant</td>
</tr>
<tr>
<td>81</td>
<td>Water Transfer pump</td>
<td>Armstrong / Groundfos / kirloskar / Crompton</td>
</tr>
<tr>
<td>82</td>
<td>Water supply pumps</td>
<td>KSB / Grundfos / Kirloskar / Crompton / Mather &amp; Platt</td>
</tr>
<tr>
<td>83</td>
<td>White Glazed Fire Clay Sink</td>
<td>Hindware / Cera / Toto / Kerovit</td>
</tr>
<tr>
<td>84</td>
<td>Eye Wash Shower</td>
<td>Euronics / HAWS / Coleparmer</td>
</tr>
<tr>
<td>85</td>
<td>WTP, ETP Cum STP System</td>
<td>Bs Enviro, Ecogured, Aldee Water</td>
</tr>
<tr>
<td>86</td>
<td>Ball cock</td>
<td>Sant / L &amp; T / Audco / GPA</td>
</tr>
<tr>
<td>87</td>
<td>Ball Valves with Float</td>
<td>Zoloto / Leader / Sant / Audco / GPA</td>
</tr>
<tr>
<td>88</td>
<td>Brass - Stop &amp; Bib Cock</td>
<td>Zoloto / Sant / Jaquar</td>
</tr>
<tr>
<td>89</td>
<td>C. I Pipes &amp; Fittings</td>
<td>Electrosteel / Kapilansh / NECO / RIF / SKF / BIC</td>
</tr>
<tr>
<td>90</td>
<td>Centrifugally Cast Iron Hubless Pipes &amp; Fitting</td>
<td>NECO / BIC / Kapilansh</td>
</tr>
<tr>
<td>91</td>
<td>C.I Sluice Valve &amp; Non Return Valve</td>
<td>Kirloskar / Leader / Zoloto / Audco / Sant</td>
</tr>
<tr>
<td>92</td>
<td>C.I Valves (Full way, Check and Globe Valves</td>
<td>Kirloskar / Leader / Zoloto / Sant</td>
</tr>
<tr>
<td>93</td>
<td>C.I. Manhole Covers</td>
<td>NECO / R.I.F. / B.I.C. / HEPCO / SKF</td>
</tr>
<tr>
<td>94</td>
<td>C.P. Fittings: Mixer / Bib Cock / Pillar taps / Angle valve / Valves Washers / Waste / Urinal /</td>
<td>Jaquar / Kohler / Grohe / Marc</td>
</tr>
<tr>
<td>S.No.</td>
<td>Details of equipment / material</td>
<td>Make/Manufacturer</td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>95.</td>
<td>C.I. Y Type Strainer</td>
<td>NVR/ Leader/ Emrald</td>
</tr>
<tr>
<td>96.</td>
<td>C.I Dual plate</td>
<td>Leader/Sant/Zaloto</td>
</tr>
<tr>
<td>97.</td>
<td>D.I. water type check valve</td>
<td>NVR/ Leader/IV/ Zoloto</td>
</tr>
<tr>
<td>98.</td>
<td>Modular Grab bars and Disabled Hardware</td>
<td>Dorma / D-line</td>
</tr>
<tr>
<td>99.</td>
<td>Stainless Steel CP Grating</td>
<td>Chilly / Camry/ Neer or equivalent</td>
</tr>
</tbody>
</table>

List of Approved Makes of Materials - Services & Related Works

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Details of equipment / material</th>
<th>Make/Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DRINKING WATER PUMPING SYSTEMS / WATER TREATMENT PLANT / REVERSE OSMOSIS ETC.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Anti-Vibration Mounting &amp; Flexible Connections</td>
<td>Dunlop/Flexionics/Kanwal/Industrial Corporation/Resistoflex</td>
</tr>
<tr>
<td>2.</td>
<td>Butterfly Valve</td>
<td>Zoloto/Audco/Kirloskar/AIP/Advance</td>
</tr>
<tr>
<td>3.</td>
<td>Cartridge Filter</td>
<td>Milton Roy/Grundfos/Big Blue</td>
</tr>
<tr>
<td>4.</td>
<td>Centralized RO Plant</td>
<td>Ion Exchange/ Thermax/ Pentair/PAMM/AWMS</td>
</tr>
<tr>
<td>5.</td>
<td>Chain Pulley Block</td>
<td>Indef/ Ardee/ J.K. Morris</td>
</tr>
<tr>
<td>6.</td>
<td>Check Valve – Dual Plate</td>
<td>Advance/Honeywell/Audco/Zoloto</td>
</tr>
<tr>
<td>7.</td>
<td>Check Valve – Wafer Type</td>
<td>Advance/Danfoss/Zoloto/Honeywell</td>
</tr>
<tr>
<td>8.</td>
<td>Conductivity Meter</td>
<td>Fox/Rosemount/Aster/Digital</td>
</tr>
<tr>
<td>9.</td>
<td>Couplings</td>
<td>Lovejoy/Dunlop/Burgmann</td>
</tr>
<tr>
<td>10.</td>
<td>Dosing Pumps</td>
<td>LMI/Pulser Feeder/Toschon/Grundfos</td>
</tr>
<tr>
<td>11.</td>
<td>Dosing Pumps</td>
<td>LMI/Pulser Feeder/Toschon/Grundfos</td>
</tr>
<tr>
<td>12.</td>
<td>Electronic Flow Meter</td>
<td>Krohne (Forbes Marshall)/Rockwin Cirrus Engineering</td>
</tr>
<tr>
<td>13.</td>
<td>Fastener</td>
<td>Fisher/Hilti/Canon</td>
</tr>
<tr>
<td>14.</td>
<td>Filter</td>
<td>Ion Exchange/ Thermax/Pentair</td>
</tr>
<tr>
<td>15.</td>
<td>Flow Meter</td>
<td>Energy/Honeywell/Cirrus Engineering</td>
</tr>
<tr>
<td>16.</td>
<td>GI / MS Pipes</td>
<td>Tata Steel/Jindal/SAIL</td>
</tr>
<tr>
<td>17.</td>
<td>GI pipes fittings</td>
<td>Unik/Jain Sons/Zoloto /DRP</td>
</tr>
<tr>
<td>18.</td>
<td>GM / Forged Brass Ball Valves</td>
<td>Zoloto/Honeywell/RB</td>
</tr>
<tr>
<td>19.</td>
<td>HDPE Tanks</td>
<td>Sintex/Amitex/Sheetal</td>
</tr>
<tr>
<td>Item No.</td>
<td>Equipment/Component</td>
<td>Brand/Make</td>
</tr>
<tr>
<td>---------</td>
<td>---------------------------------------------------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>20.</td>
<td>High Pressure Pumps</td>
<td>DP/Grundfos/ITT/Willo-Mather Platt</td>
</tr>
<tr>
<td>21.</td>
<td>Hydro-pneumatic System</td>
<td>HBDGM/ Grundfoss / Salmson / Nocchi / Kirloskar / DP Holland / Wilo</td>
</tr>
<tr>
<td>22.</td>
<td>Level Controller &amp; Indicator (Water)</td>
<td>Auto Pump/Cirrus Engineering/Technika Techtrol</td>
</tr>
<tr>
<td>23.</td>
<td>Mechanical Seal</td>
<td>Burgmann/Sealol/Dunlop</td>
</tr>
<tr>
<td>24.</td>
<td>Non return valve</td>
<td>Zoloto/Honeywell/RB</td>
</tr>
<tr>
<td>25.</td>
<td>ORP Meter</td>
<td>Fox/Rosemount/ Rapid Control/ Maharaja / Waltronics</td>
</tr>
<tr>
<td>27.</td>
<td>pH Meter</td>
<td>Fox/Rosemount/Aster/Digital</td>
</tr>
<tr>
<td>28.</td>
<td>Pipe clamp &amp; supports</td>
<td>Chilly/Euroclamp/Kanwal</td>
</tr>
<tr>
<td>29.</td>
<td>Pipe clamp &amp; supports</td>
<td>Chilly/Euroclamp/Kanwal</td>
</tr>
<tr>
<td>30.</td>
<td>Portable RO Plant</td>
<td>Bluestar/Usha/Eureka/ Forbes/ Kent/ Prestige/ Voltas / AO Smith</td>
</tr>
<tr>
<td>31.</td>
<td>Pressure Gauge</td>
<td>Fiebig/ Emerald/H. Guru/Baumer</td>
</tr>
<tr>
<td>32.</td>
<td>Pressure Switch</td>
<td>Switzer/Honeywell/Indfoss</td>
</tr>
<tr>
<td>33.</td>
<td>Raw Water Pump Set/ Treated Water pump set/ Drainage Pump Set or any other type of pump sets.</td>
<td>DP/Grundfos/ITT/Willo-Mather Platt/KSB</td>
</tr>
<tr>
<td>34.</td>
<td>Resin</td>
<td>Ion Exchange/Thermax/3M/Pentair</td>
</tr>
<tr>
<td>35.</td>
<td>RO Membrane with Housing</td>
<td>Dow/Hydranautics/Tricep/G.E/Mitsubishi</td>
</tr>
<tr>
<td>36.</td>
<td>Sluice Valves</td>
<td>IVC/Kirloskar/ Zoloto</td>
</tr>
<tr>
<td>37.</td>
<td>Sodium Hypochlorite Dosing System</td>
<td>Asia LMI/ Grundfoss/ Seiko/ E - Dose</td>
</tr>
<tr>
<td>38.</td>
<td>Softener Vessel</td>
<td>Ion Exchange/Thermax/Pentair</td>
</tr>
<tr>
<td>39.</td>
<td>SS 316 Pipes</td>
<td>Jindal/ Viega/Sumito</td>
</tr>
<tr>
<td>40.</td>
<td>SS 316 Strainer</td>
<td>Normax/Swadeshi/Worth valve</td>
</tr>
<tr>
<td>41.</td>
<td>SS 316 Valves</td>
<td>Audco/ Zoloto /Leader/Walson</td>
</tr>
<tr>
<td>42.</td>
<td>Storm Water Drainage &amp; Sewage Sump Pumps (Submersible)</td>
<td>DP/Grundfos/Xylem-ITT/Willo-Mather Platt</td>
</tr>
<tr>
<td>43.</td>
<td>Transfer Pumps</td>
<td>DP/Grundfos/Xylem -ITT/Willo-Mather Platt</td>
</tr>
<tr>
<td>44.</td>
<td>Water Meter (Mechanical Type)</td>
<td>As per Plumbing &amp; Sanitary make list</td>
</tr>
<tr>
<td>45.</td>
<td>Welding Rods</td>
<td>ADORR/Esab/Advani/ Victor</td>
</tr>
</tbody>
</table>
### HOT WATER GENERATOR SYSTEM

<table>
<thead>
<tr>
<th></th>
<th>Item</th>
<th>Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Air release valve/ Insulation/ Thermometer/ Pressure Gauge</td>
<td>As per Approved makes for HVAC Works.</td>
</tr>
<tr>
<td>2</td>
<td>Ball valve /Check valve/“Y” – strainer/ GI/MS pipes</td>
<td>As per Approved makes for Fire Fighting Works.</td>
</tr>
<tr>
<td>3</td>
<td>Hot Water Generators</td>
<td>Enmax/ Sunmax/ Goodsun / TATA Power Solar / Thermax/ Rapid Control</td>
</tr>
<tr>
<td>4</td>
<td>Recirculating pumps</td>
<td>Grundfos/ DP /Mather Platt – Wilo/KSB</td>
</tr>
</tbody>
</table>

### SOLAR PV/ HOT WATER SYSTEM

<table>
<thead>
<tr>
<th></th>
<th>Item</th>
<th>Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Solar PV System</td>
<td>Tata Power Solar / Havells Solar Edge/ Schneider/ Socomec/ Emmvee/ Thermax</td>
</tr>
<tr>
<td>3</td>
<td>Butterfly Valve</td>
<td>Audco/Danfoss/Honeywell/Zoloto</td>
</tr>
<tr>
<td>4</td>
<td>Check Valve – Dual Plate</td>
<td>Advance/Honeywell/Audco/Zoloto</td>
</tr>
<tr>
<td>5</td>
<td>Check Valve – Wafer Type</td>
<td>Advance/Danfoss/Zoloto/Honeywell</td>
</tr>
<tr>
<td>6</td>
<td>CPVC pipes</td>
<td>Supreme/Ashirwad/Astral</td>
</tr>
<tr>
<td>7</td>
<td>GI Pipes</td>
<td>Tata Steel/Jindal (Hissar)/ SAIL</td>
</tr>
<tr>
<td>8</td>
<td>GM / Forged Brass Ball Valves</td>
<td>Danfoss/Honeywell/Zoloto</td>
</tr>
<tr>
<td>9</td>
<td>Heat Exchanger</td>
<td>GEA Eco flex/Alfa Level or equivalent</td>
</tr>
<tr>
<td>10</td>
<td>Hot Water Recirculation OR other Pumps</td>
<td>DP – Holland/Grundfos /Xylem - ITT/ Wilo – Mather Platt</td>
</tr>
<tr>
<td>11</td>
<td>Insulation for Hot Water Pipes</td>
<td>Armacell – Armaflex/Eurobatex – Union Foam K-Flex/ Thermaflex</td>
</tr>
<tr>
<td>12</td>
<td>Level Controller &amp; Indicator (Water)</td>
<td>Auto Pump/Cirrus Engineering/Technika / Techtrtol</td>
</tr>
<tr>
<td>13</td>
<td>Pipe clamp &amp; supports</td>
<td>Chilly/ Euroclamp/ Kanwal</td>
</tr>
<tr>
<td>14</td>
<td>Sluice Valves</td>
<td>IVC/ Kirloskar/ Advance</td>
</tr>
<tr>
<td>15</td>
<td>Solenoid Valve</td>
<td>Danfoss/ Avcon/ Honey well</td>
</tr>
<tr>
<td>16</td>
<td>Water Meter</td>
<td>As per Plumbing &amp; Sanitary make list</td>
</tr>
<tr>
<td>No.</td>
<td>Description</td>
<td>Brand(s)</td>
</tr>
<tr>
<td>-----</td>
<td>------------------------------------------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>17</td>
<td>Y Strainer</td>
<td>Leader/ Zoloto/ Audco/ Castle/ Emerald/ Rapid cool/ Advance</td>
</tr>
<tr>
<td>18</td>
<td>Heat Pump</td>
<td>Daikin/Emerson/Cristopia/Bluebox, Climaveneta/Certikin</td>
</tr>
</tbody>
</table>

**ELECTRICAL WORKS**

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Brand(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11 KV HT Panel with 11kV Vacuum Circuit Breaker (VCB)</td>
<td>L&amp;T/ ABB / Schneider/ Siemens or their authorized Channel Partner</td>
</tr>
<tr>
<td>2</td>
<td>33/66 kV HT Panel with 33/66 kV SF6 Breaker</td>
<td>L&amp;T/ ABB / Schneider/ Siemens or their authorized Channel Partner</td>
</tr>
<tr>
<td>3</td>
<td>33/66 kV HT Panel with 33/66 kV Vacuum Circuit Breaker (VCB)</td>
<td>L&amp;T/ ABB / Schneider/ Siemens or their authorized Channel Partner</td>
</tr>
<tr>
<td>4</td>
<td>ACB (TP,4P) with variable microprocessor</td>
<td>L&amp;T (U-Power Omega)/ Siemens (3 WL)/ Schneider (MVS) / ABB (Emax)/Legrand (DMX3)</td>
</tr>
<tr>
<td>5</td>
<td>Automatic Transfer Switch (ATS)</td>
<td>L&amp;T/ ABB/ Siemens/ Schneider / Socomec</td>
</tr>
<tr>
<td>6</td>
<td>Auto Changeover &amp; Current Limiter (ACCL)</td>
<td>Indo Asian/ Havells/ Salzer/ Elmeasure/ L&amp;T/ ABB / Siemens/ Schneider/ Legrand</td>
</tr>
<tr>
<td>7</td>
<td>Auxiliary relays compatible with PLC etc.</td>
<td>Siemens/ L&amp;T/ ABB/ Areva/ Schneider</td>
</tr>
<tr>
<td>8</td>
<td>Batteries</td>
<td>Hitachi/Panasonic/ Yuasa/ SF/ Exide/ Amco/ Amaraja</td>
</tr>
<tr>
<td>9</td>
<td>Battery Charger</td>
<td>Amaraja/ Sabnife/ Statcon/ Volstat/ HBL</td>
</tr>
<tr>
<td>10</td>
<td>Battery Charger-cum-DCDB</td>
<td>Amaraja/ Volstat/Caldyne/ Expo-Fyn/ BCH/ HBL</td>
</tr>
<tr>
<td>11</td>
<td>Boom Barrier</td>
<td>FAAC/ Godrej Vigiguard/ Somfy/Gunnebo</td>
</tr>
<tr>
<td>12</td>
<td>Brass compression Gland (Heavy duty)</td>
<td>Commex/ Gripwell/ Dowell</td>
</tr>
<tr>
<td>13</td>
<td>Bus bar</td>
<td>Jindal/ Hindalco/ Indal</td>
</tr>
<tr>
<td>14</td>
<td>Bus Duct - Sandwich</td>
<td>L&amp;T/ Schneider/ C&amp;S/ Godrej/ Legrand/ EAE</td>
</tr>
<tr>
<td>15</td>
<td>Bus trunking, rising mains, end feed unit, top-off box (plug-in type)</td>
<td>L&amp;T/ Schneider/ C&amp;S/ Godrej/ Legrand/ EAE</td>
</tr>
<tr>
<td>16</td>
<td>Cable Jointing Kit / HT termination Kit</td>
<td>Reychem/ Xicon/ 3M</td>
</tr>
<tr>
<td>17</td>
<td>Cable Lugs &amp; Glands</td>
<td>Dowel/ Johnson/ Gripwell/ Comex/ Hex/ Comet</td>
</tr>
<tr>
<td>18</td>
<td>Cable Tray/ Race ways / Floor trunking / wall channels</td>
<td>MEM/ BEC/ OBO Bettermann/ Indiana/ Legrand/ RMCON</td>
</tr>
<tr>
<td>No.</td>
<td>Item Description</td>
<td>Brands</td>
</tr>
<tr>
<td>-----</td>
<td>--------------------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>19.</td>
<td>Capacitors with harmonic filters</td>
<td>L&amp;T/ Siemens / Schneider/ ABB/ Ducati</td>
</tr>
<tr>
<td>20.</td>
<td>Ceiling /Exhaust/Wall fans</td>
<td>Crompton/ Usha/ Orient/ Bajaj/ Havells</td>
</tr>
<tr>
<td>21.</td>
<td>Chemical Earthing</td>
<td>JMV LPS Ltd./ Pragati Electrocom</td>
</tr>
<tr>
<td>22.</td>
<td>Coaxial Wires</td>
<td>Finolex/ Delton/ Skytone/ L&amp;T/ KEI/ Finolex/ Gloster</td>
</tr>
<tr>
<td>23.</td>
<td>Colour Monitor</td>
<td>Samsung/ LG/ Sony/ Philips</td>
</tr>
<tr>
<td>24.</td>
<td>Compression Gland and Lugs / thimbles</td>
<td>Dowel/ Comet/ Gripwell</td>
</tr>
<tr>
<td>25.</td>
<td>Contactors</td>
<td>ABB/ L&amp;T/ Schneider/ Siemens</td>
</tr>
<tr>
<td>26.</td>
<td>Control fuse base with HRC Fuse</td>
<td>L&amp;T/ Siemens/ ABB/ Alstom/ Schiende</td>
</tr>
<tr>
<td>27.</td>
<td>Crimping Lugs/ Thimbles</td>
<td>Dowells/ Hex/ Commet</td>
</tr>
<tr>
<td>28.</td>
<td>CT/ PT's</td>
<td>L&amp;T/ Kappa/ C&amp;S/ CGL/ AE / Meco</td>
</tr>
<tr>
<td>29.</td>
<td>Cubicle Type Fuse Unit/ RMU</td>
<td>Siemens/ L&amp;T/ ABB/ Schneider</td>
</tr>
<tr>
<td>30.</td>
<td>Data/Telephone/TV Outlets</td>
<td>Systemax/ Belden/ Simone/ MK/ Legrand/ Havells/ Anchor</td>
</tr>
<tr>
<td>31.</td>
<td>DB's</td>
<td>Hager/ Havells/ Legrand/ L&amp;T/ Schneider/ ABB/ Siemens</td>
</tr>
<tr>
<td>32.</td>
<td>DG Set - Assembler</td>
<td>Jakson &amp; Company / Jakson Ltd/ Sterling Generators / Sudhir Gensets/ Powerica/ Kirloskar (KOEL authorized OEM) / TIPL (Gainwell)</td>
</tr>
<tr>
<td>33.</td>
<td>DG Set - Alternator</td>
<td>Stamford/ Leroy Somer/ Toyo Denki/ AVK-SEG/ Kirloskar (KOEL Green)</td>
</tr>
<tr>
<td>34.</td>
<td>DG Set - Engine</td>
<td>Cummins/ Mitsubishi/ Perkins/ Volvo/ Caterpiller/ Kirloskar (KOEL Green)</td>
</tr>
<tr>
<td>35.</td>
<td>DG Synchronizing Controller</td>
<td>Woodward/ Dief/ Deep sea</td>
</tr>
<tr>
<td>36.</td>
<td>Digital Lighting Control System</td>
<td>Wipro/ Siemens/ Philips/ Schneider/ ABB/ L&amp;T</td>
</tr>
<tr>
<td>37.</td>
<td>Digital Numerical Relays</td>
<td>L&amp;T/ ABB / Siemens/ Schneider/ Areva</td>
</tr>
<tr>
<td>38.</td>
<td>DWC HDPE Pipe</td>
<td>DURA-LINE / REX / CARLON/ EMTELLE</td>
</tr>
<tr>
<td>40.</td>
<td>Electrical Motors</td>
<td>L&amp;T/ ABB/ Siemens/ Kirloskar</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Supplier Options</td>
</tr>
<tr>
<td>---</td>
<td>-------------------------------------------------</td>
<td>------------------------------------------------------</td>
</tr>
<tr>
<td>41.</td>
<td>Optical Fiber Cable</td>
<td>Sterlite Technologies/ Finolex/ Belden/ Delton/ Skytone</td>
</tr>
<tr>
<td>42.</td>
<td>Fire Extinguisher</td>
<td>Ceasefire/ Exflame/ Minimax/ Life Guard/ Safex</td>
</tr>
<tr>
<td>43.</td>
<td>Fire Survival Cables</td>
<td>KEI/ Polycab/ Havells/ Fusion Polymers/ Wrexham cables</td>
</tr>
<tr>
<td>44.</td>
<td>PVC insulated FRLS - Aluminum / Copper 1.1 KV grade flexible wires</td>
<td>L&amp;T/ Gloster/ Havells/ Polycab / Finolex/ RR Kable/ KEI</td>
</tr>
<tr>
<td>45.</td>
<td>G.I./Cu. Strip &amp; earthing material</td>
<td>Bharati/ Indiana/ Slotco/ JMV</td>
</tr>
<tr>
<td>46.</td>
<td>Hand Gloves &amp; Rubber Mat</td>
<td>Premier Polyfilm Ltd/ Polyelectrosafe/ Challenger/ Electromat/ Safe Hold</td>
</tr>
<tr>
<td>47.</td>
<td>HRC Fuse</td>
<td>Siemens/ L&amp;T/ ABB/ Schneider</td>
</tr>
<tr>
<td>48.</td>
<td>HT &amp; LT Cables (Power &amp; Control Cables, Solar Cables)</td>
<td>Gloster/ Havells/ Nicco/ Finolex/ KEI/Polycab</td>
</tr>
<tr>
<td>49.</td>
<td>Indicating Lamps</td>
<td>AE/ Kaycee/ Vaishnav/ L&amp;T/ Siemens/ Schnieder/ Teknik/ ABB</td>
</tr>
<tr>
<td>50.</td>
<td>Industrial Socket Outlets</td>
<td>ABB/ L&amp;T/ Legrand/ Siemens/ Hager</td>
</tr>
<tr>
<td>51.</td>
<td>Insulated Rubber Mat</td>
<td>Premier Polyfilm Ltd/ Polyelectrosafe/ Challenger/ Electromat/ Safe Hold</td>
</tr>
<tr>
<td>52.</td>
<td>Insulators</td>
<td>Jaya Shree/ Modern/ IEC/ WSI/ APS</td>
</tr>
<tr>
<td>53.</td>
<td>Inverter</td>
<td>Microtek / Luminous / Su-Kam/ Eaton</td>
</tr>
<tr>
<td>54.</td>
<td>Isolators</td>
<td>Siemens/ L&amp;T/ ABB/Socomec/ Schnieder</td>
</tr>
<tr>
<td>55.</td>
<td>Isolation Panels for Modular OT</td>
<td>Pieco/ Schnieder/ L&amp;T/ ABB/ Siemens/ Hakel</td>
</tr>
<tr>
<td>56.</td>
<td>Jointing Kit</td>
<td>Reychem/ Xicon/ Birla-3M</td>
</tr>
<tr>
<td>57.</td>
<td>LED Light Fixtures and Lamps</td>
<td>Philips/ Wipro/ Trilux/ Lighting Technologies / Havells/ Bajaj</td>
</tr>
<tr>
<td>58.</td>
<td>Lighting for Facade</td>
<td>Philips/ Wipro/ Trilux /Allurays/RZB/BEGA</td>
</tr>
<tr>
<td>59.</td>
<td>Lightening Protection</td>
<td>L&amp;P ELECTRO/ LPI/ Indelec/ OBO Bettermann/ APS/ Hakel/ JMV</td>
</tr>
<tr>
<td>60.</td>
<td>LT Panels / Synchronizing Panels/ Capacitor Panels</td>
<td>L&amp;T/ ABB / Schneider/ Siemens/ Legrand or their Authorized Channel Partners</td>
</tr>
<tr>
<td>61.</td>
<td>MCBs / RCCB/Isolaters / RCBO / Change over switch</td>
<td>Hager/ Havells/ Legrand/ L&amp;T/ Schneider/ ABB/ Siemens/ Indoasian (Optipro)</td>
</tr>
<tr>
<td>No.</td>
<td>Description</td>
<td>Brands</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>62.</td>
<td>MCCB with Variable Microprocessor based (O/C, S/C, E/F) / Thermo magnetic releases</td>
<td>L&amp;T (D-sine)/ Schneider (CVS)/ ABB (Tmax)/ Siemens (3VA)/ Legrand (DPX2)</td>
</tr>
<tr>
<td>63.</td>
<td>Measuring Instruments (Analog Meter)</td>
<td>L&amp;T/ AE/ MECO/ Rishabh/ Schneider</td>
</tr>
<tr>
<td>64.</td>
<td>Measuring Instruments (Digital Type)/ MFM/KWH meter</td>
<td>L&amp;T/ Ducati/ Conzerv/ Secure/ Siemens/ Schneider/ ABB</td>
</tr>
<tr>
<td>65.</td>
<td>Modular Switches/ Socket outlets and wiring accessories with moulded cover plate</td>
<td>MK (Elements) / Siemens (Delta)/ Legrand (Arteor)/ L&amp;T (Entice)/ Havells (Crabtree-Murano)/ Schneider (Opale)/ Wipro (North West-Platia)/ ABB (Ivie)/ IndoAsian (Elvira)</td>
</tr>
<tr>
<td>66.</td>
<td>MPCB</td>
<td>L&amp;T/ Siemens/ ABB/ Schneider</td>
</tr>
<tr>
<td>67.</td>
<td>MS Conduit</td>
<td>BEC/ AKG/ Steel Kraft/ RMCON</td>
</tr>
<tr>
<td>68.</td>
<td>MS Conduit accessories</td>
<td>BEC/ AKG/ Steel Kraft/ RMCON</td>
</tr>
<tr>
<td>69.</td>
<td>Multi-function Meter</td>
<td>L&amp;T/ ABB / Siemens/ Schneider</td>
</tr>
<tr>
<td>70.</td>
<td>Nurse Call System</td>
<td>Schrack Seconet/ Honeywell/ Rauland-Borg/ Austco</td>
</tr>
<tr>
<td>71.</td>
<td>Occupancy Sensors/ Lighting Control System</td>
<td>Phillips/ Schneider/ Legrand/ Wipro/L&amp;T/ Havells</td>
</tr>
<tr>
<td>72.</td>
<td>Overload relay &amp; Single phase preventer</td>
<td>ABB/ L&amp;T/ Siemens/ Schneider</td>
</tr>
<tr>
<td>73.</td>
<td>Package/ Unitised Substation</td>
<td>ABB/ Siemens/ Schneider/ C&amp;S</td>
</tr>
<tr>
<td>74.</td>
<td>Panel Accessories</td>
<td>L&amp;T/ Teknic/ Rishabh/ Siemens/ Schneider</td>
</tr>
<tr>
<td>75.</td>
<td>Power Capacitor</td>
<td>L&amp;T/ Meher/ EPCOS/ Siemens/ Schneider</td>
</tr>
<tr>
<td>76.</td>
<td>Programmable timer (self-powered electronic digital) /Astronomer</td>
<td>L&amp;T/ Siemens/ Hager/ Havells/ Legrand/ Schneider</td>
</tr>
<tr>
<td>77.</td>
<td>Protective relays (Microprocessor based compatible with PC &amp; PLC)</td>
<td>Siemens/ L&amp;T/ ABB/ Areva/ Schneider</td>
</tr>
<tr>
<td>78.</td>
<td>Push Buttons</td>
<td>Siemens/ L&amp;T/ ABB/ Schneider/ C&amp;S/ Teknik</td>
</tr>
<tr>
<td>79.</td>
<td>PVC Conduit &amp; Accessories</td>
<td>Clipsal/ Polypack/ BEC/ AKG/ Norpack</td>
</tr>
<tr>
<td>80.</td>
<td>Relay / Contractors/ Timers / Starters and Control Panel</td>
<td>Siemens/L&amp;T/Schneider/ ABB</td>
</tr>
<tr>
<td>81.</td>
<td>Selector Switch</td>
<td>Siemens/ L&amp;T/ Teknic/ Salzer/ Schneider/ ABB</td>
</tr>
<tr>
<td>82.</td>
<td>Street Light Poles &amp; Light Fixtures – Conventional</td>
<td>Philips/ Wipro/ Havells/ Bajaj</td>
</tr>
<tr>
<td></td>
<td>Product</td>
<td>Vendor Options</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>83.</td>
<td>Solar Street Light Poles &amp; Fixtures (All in One)</td>
<td>Philips/ Wipro/ Havells/ Bajaj</td>
</tr>
<tr>
<td>84.</td>
<td>Surge Diverter</td>
<td>Tercel/ ABB/ Siemens/ Emerson/ Hager/ Phoenix/ Legrand</td>
</tr>
<tr>
<td>85.</td>
<td>SCADA &amp; BMS System</td>
<td>Schneider/ L&amp;T/ Honeywell/ Siemens/ ABB</td>
</tr>
<tr>
<td>86.</td>
<td>Tap-off/ Splitter Box</td>
<td>Zinwell/ Novatron/ Catvision</td>
</tr>
<tr>
<td>87.</td>
<td>Telephone Tag Block/Jack Panel/ Face Plate</td>
<td>Krone/ Phoenix/ Wago/ Beldon/ Panduit/ Huawei</td>
</tr>
<tr>
<td>88.</td>
<td>Terminal Strip</td>
<td>Connect well/ Phoenix/ WAGO</td>
</tr>
<tr>
<td>89.</td>
<td>Termination Kits</td>
<td>Raychem/ Birla/ 3M</td>
</tr>
<tr>
<td>90.</td>
<td>Transformer (Oil Type / Dry Type)</td>
<td>ABB/ Siemens/ Kirloskar/ Voltamp/ Areva/ Schneider</td>
</tr>
<tr>
<td>91.</td>
<td>Trivector - Meter (Digital type) only for SEB supply</td>
<td>L&amp;T/ Secure meter/ Enercon/ Siemens/ Socomec/ Schneider</td>
</tr>
<tr>
<td>92.</td>
<td>UPS</td>
<td>Emerson (Vertiv)/ Schnieder (APC)/ Eaton/ Socomec/ Delta</td>
</tr>
<tr>
<td>93.</td>
<td>Variable Frequency Drive</td>
<td>L&amp;T/ Siemens/Danfoss/ABB/ Schneider</td>
</tr>
</tbody>
</table>

**FIRE FIGHTING WORKS**

<table>
<thead>
<tr>
<th></th>
<th>Product</th>
<th>Vendor Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Air Release Valve/Air Cushion Tank</td>
<td>Zoloto/Advance/Leader/Audco/Castle</td>
</tr>
<tr>
<td>2.</td>
<td>Alarm Valve &amp; Hydraulic (Alarm motor with coupling)</td>
<td>HD fire protect/TYCO/VIKING/Newage</td>
</tr>
<tr>
<td>3.</td>
<td>Alternator</td>
<td>Stamford/ Lorey Somer/ Kirloskar/ Toyo Denki/ AVK</td>
</tr>
<tr>
<td>4.</td>
<td>Ammeter/ Voltmeter/ PF/ kW/ Hz/ meter /Energy Meter/ Multimeter</td>
<td>As per respective electrical make list</td>
</tr>
<tr>
<td>5.</td>
<td>Anchor Fastener</td>
<td>Fischer / Hilti /Wurth</td>
</tr>
<tr>
<td>6.</td>
<td>Ball Valves</td>
<td>L&amp;T/ Audco/ Zoloto/ Advance/Emerald/ KSB/ Kirloskar</td>
</tr>
<tr>
<td>7.</td>
<td>Battery</td>
<td>Exide/ AMCO /Amararaja/ Panasonic</td>
</tr>
<tr>
<td>8.</td>
<td>Butt welded fitting (UL Listed) &amp; accessories</td>
<td>V.S. Forge/True Forge / DRP-M</td>
</tr>
<tr>
<td>9.</td>
<td>Butterfly valves</td>
<td>L&amp;T/ Audco/ Zoloto / Advance/ KSB</td>
</tr>
<tr>
<td>10.</td>
<td>Cable lugs and glands</td>
<td>As per electrical make list</td>
</tr>
<tr>
<td>11.</td>
<td>Cables</td>
<td>As per electrical make list</td>
</tr>
<tr>
<td>12.</td>
<td>Check Valve/Foot Valve/Sluice Valve/ NRV</td>
<td>L&amp;T/Audco / Zoloto Advance/KSB</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Supplier Options</td>
</tr>
<tr>
<td>---</td>
<td>------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>13.</td>
<td>Control / Potential / Current Transformer</td>
<td>As per respective electrical make list</td>
</tr>
<tr>
<td>14.</td>
<td>Deluge valve/ Solenoid valve/ Spray nozzle</td>
<td>HD / Tyco/Viking</td>
</tr>
<tr>
<td>15.</td>
<td>Diesel engine driven pump</td>
<td>Ashok Leyland/ Cummins / Perkins/ WILO-Mather &amp; Platt/ Kirloskar/Armstrong Fluid Technology</td>
</tr>
<tr>
<td>16.</td>
<td>ELCB</td>
<td>As per electrical make list</td>
</tr>
<tr>
<td>17.</td>
<td>Epoxy Paint</td>
<td>As per Civil Works make list</td>
</tr>
<tr>
<td>18.</td>
<td>Fire Buckets</td>
<td>Safex / Minimax/ Cease Fire / Peter Autokit</td>
</tr>
<tr>
<td>19.</td>
<td>Fire Extinguisher</td>
<td>Minimax / Newage/ Eversafe/ Tyco –Johnsons Control</td>
</tr>
<tr>
<td>20.</td>
<td>Fire Hydrant Valves/ Fire RRL Hose Pipes / Fire Hose Reels/ Fire Man’s Axe/ Gun metal short branch pipe/ 2/ 3/4 FB inlet/ draw Out connection/Hose Box/Hose reel drum /Nozzle/ blank Caps &amp; Chains / Coupling</td>
<td>Ceasefire / Newage/ Minimax/HD/Tyco</td>
</tr>
<tr>
<td>22.</td>
<td>Electrical Motors</td>
<td>ABB/ Siemens/Kirloskar/C&amp;G/BALDOR</td>
</tr>
<tr>
<td>23.</td>
<td>Flow Meter</td>
<td>Scientific Equipments(p) Ltd./System Sensor or equivalent</td>
</tr>
<tr>
<td>24.</td>
<td>Flow switch</td>
<td>Potter / Rapid flow/Danfoss/Viking/Belimo/Honeywell</td>
</tr>
<tr>
<td>25.</td>
<td>Foot Valve (Cast iron/ Gunmetal)</td>
<td>Kirloskar / Zoloto/Advance/L&amp;T</td>
</tr>
<tr>
<td>26.</td>
<td>Forged steel fitting &amp; accessories</td>
<td>V.S.Forge/True Forge / DRP-M</td>
</tr>
<tr>
<td>27.</td>
<td>GI clamps</td>
<td>Chilly/Hilti or equivalent</td>
</tr>
<tr>
<td>28.</td>
<td>GI / MS Pipes</td>
<td>Tata / Jindal- Hisar/ SAIL</td>
</tr>
<tr>
<td>29.</td>
<td>Gunmetal Valves (Globe Valves)</td>
<td>Audco / Zoloto Advance/L&amp;T</td>
</tr>
<tr>
<td>30.</td>
<td>Over Load Relays</td>
<td>As per electrical make list</td>
</tr>
<tr>
<td>31.</td>
<td>Pipe coat material (pipe protection)</td>
<td>Pypcoat / Makphalt / Safex</td>
</tr>
<tr>
<td>32.</td>
<td>Pipe Hangers/ Clamps/Supports</td>
<td>Chilly/ GMGR /CAMRY/Hilti</td>
</tr>
<tr>
<td>33.</td>
<td>Power/auxiliary Contactors</td>
<td>As per electrical make list</td>
</tr>
<tr>
<td></td>
<td>Item</td>
<td>Supplier</td>
</tr>
<tr>
<td>---</td>
<td>-------------------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>34.</td>
<td>Pressure Gauge</td>
<td>Fiebig/H.GURU/HD/BRC</td>
</tr>
<tr>
<td>35.</td>
<td>Pressure Switch</td>
<td>Indfoss/ H.GURU/HD/ Switzer/</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Danfoss/ Honeywell</td>
</tr>
<tr>
<td>36.</td>
<td>Push Buttons/ Indicating lamps LED</td>
<td>As per respective electrical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>make list</td>
</tr>
<tr>
<td>37.</td>
<td>Single Phase Preventer</td>
<td>As per electrical make list</td>
</tr>
<tr>
<td>38.</td>
<td>Solenoid valve/ Spray nozzle</td>
<td>HD/Tyco/Danfoss/Honeywell</td>
</tr>
<tr>
<td>39.</td>
<td>Sprinkler Heads (Sidewall/ Upright/ Pendant)</td>
<td>Grinnel-Tyco/Viking/HD</td>
</tr>
<tr>
<td>40.</td>
<td>Steel flexible extension</td>
<td>Eversafe/Newage/Tyco/Viking</td>
</tr>
<tr>
<td>41.</td>
<td>Vibration Eliminator</td>
<td>Resistoflex/D’wren/Kanwal</td>
</tr>
<tr>
<td>42.</td>
<td>Weld Electrodes</td>
<td>Advani/ ESAB/L&amp;T/Victor/Ador</td>
</tr>
<tr>
<td>43.</td>
<td>Pot strainer</td>
<td>Emerald/VTM/Rapid Cool</td>
</tr>
<tr>
<td>44.</td>
<td>Y-Strainer</td>
<td>Zoloto/Audco/Emerald/Advance</td>
</tr>
<tr>
<td>45.</td>
<td>Rubber Bellows</td>
<td>Resistoflex/Easyflex/Kanwal</td>
</tr>
<tr>
<td>46.</td>
<td>Fire Suppression System/ Gas Flooding System</td>
<td>Tyco/Newage/Minimax/Viking</td>
</tr>
<tr>
<td>47.</td>
<td>Linear Pneumatic Heat Detection Tube System</td>
<td>Firetrex/UTC/Tracefire/Jactone/</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rotarex</td>
</tr>
<tr>
<td>48.</td>
<td>Clean Agent Fire Extinguisher</td>
<td>Kanex/Tyco/Newage/SVS Buildwell/Minimax/Lifeguard/Cestarfe</td>
</tr>
</tbody>
</table>

**FIRE ALARM SYSTEM**

Note: All fire alarm components/ Panels shall be UL listed & confirm to NFPA standards.

<table>
<thead>
<tr>
<th></th>
<th>Item</th>
<th>Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Control Cable</td>
<td>RR Cable/Bonton/Havells/Polycab/Finolex/KEI</td>
</tr>
<tr>
<td>2.</td>
<td>Intelligent Addressable Fire Alarm Panel/Detectors/ Hooters/Manual Call Point UL Listed/ Talkback/Control Module/ Monitor Module/ Control relay Module/ Short Ckt. Isolator/</td>
<td>Honeywell/Bosch/Edwards/Tyco-Simplex/Siemens</td>
</tr>
<tr>
<td>3.</td>
<td>Intelligent Addressable Fire Alarm System</td>
<td>Honeywell/Bosch/Edwards/Tyco-Simplex/Siemens</td>
</tr>
<tr>
<td>4.</td>
<td>Response Indicator</td>
<td>Honeywell/Bosch/Edwards/Tyco-Simplex/Siemens</td>
</tr>
<tr>
<td>5.</td>
<td>Fire Survival Cable</td>
<td>Bonton/Skytone/Fusion Polymers/KEI/Havells/Polycab/Wrexham</td>
</tr>
<tr>
<td>6.</td>
<td>Fire Annunciation Panel</td>
<td>Minilec/Honeywell-Notifier/Siemens/Tyco-Simplex</td>
</tr>
</tbody>
</table>
7. Panic Button | Eureka Forbes/ Fire Pro / Tyco  
8. Photo Chromatic Switch | Bajaj/ Wipro/Phillips/L&T  
9. Splitter Box | Shyam Antenna/ CAT vision or equivalent  
10. Termination Control Cable | Dowell’s/ Elemex/ Wago/ Phoenix  

**LIFTS**

1. Lifts | OTIS/ Kone / Mitsubishi/ Schindler/ Johnson / Thyssenkrupp  
2. Dumb Waite Lifts | OTIS/ Kone / Schindler/ Sigma/East India  

**LV System/ PA System/ CCTV System/ Access Control System/ Door Interlocking System:**

1. Door Controller, Card Reader, Biometric Reader, Access Control server Software, Smart card | Honeywell/Bosch/HID/Spectra/ Morpho  
2. E Magnetic lock | Honeywell/Bosch/HID/Spectra/ Morph  
3. Amplifier | Bosch/ Honeywell/ Bose  
4. CAT 6/6a Wire/Accessories - Jack Panel / Face Plate | Belden/ Simone/ Panduit/ Commscope/ Cisco/ Legrand/TADIRAN  
5. CCTV Camera/ NVR/Central Monitoring Software / Other Items | Honeywell / Pelco /Cisco /Bosch/ Axis/Sony/Impulse  
6. CD / DVD Player | Bosch/ Honeywell/Bose  
7. Door Interlocking System | NRH/Eltech/Avon  
8. PA Speaker, Voice controller, paging station, Microphone | Bosch/ Honeywell/Bose  
9. RG 6, RG 11/Wire / Coaxial Cables | Belden/ Skytone/ Bonton/ Finolex/ KEI/ Polycab/ Legrand  
10. Speaker Wire | Bonton/Delton/Polycab/KEI/ Legrand  

**HVAC SYSTEM**

1. 2-Way Pressure Independent Balancing & Control Valve | Siemens/ Danfoss/Oventrop /Belimo  
2. Adhesives for Insulation | Pidilite/Superlon / Armacell  
3. Adjustable Frequency Drive/ Automatic AFD Bypass/ Pump Controller/ Differential Pressure Sensor/ Transmitter | Xylem-ITT/Grundfos/Armstrong or as per OEMs  
4. Air Cooled Package Units | Voltas/ Bluestar/HITACHI or equivalent
## Technical Specifications

<table>
<thead>
<tr>
<th>No.</th>
<th>Item Description</th>
<th>Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>Air &amp; Dirt Separator/Dirt Separator</td>
<td>Spirotech/ Calefi/ Optivent / Spirotherm/ Flamco/ Armstrong</td>
</tr>
<tr>
<td>6.</td>
<td>Air Distribution (Ducting) -GI/GSS Sheets</td>
<td>SAIL / TATA Steel/ Jindal-Hissar</td>
</tr>
<tr>
<td>7.</td>
<td>Air Handling Units with Coils etc.</td>
<td>Zeco/ Edgetech/VTS/Waves/Flaktwood</td>
</tr>
<tr>
<td>8.</td>
<td>Air Louvers – Fresh/ Exhaust</td>
<td>Titus/ Trox/ Systemair/Carryaire/ Conaire/ Mapro/ Airflow</td>
</tr>
<tr>
<td>9.</td>
<td>Air Washer</td>
<td>Zeco/ Waves/ Edgetech/ VTS/Humidin</td>
</tr>
<tr>
<td>10.</td>
<td>Aluminium Sheet for Ducts</td>
<td>Jindal/ Hindalco/ Indal</td>
</tr>
<tr>
<td>11.</td>
<td>Automatic Air Vent</td>
<td>Anergy / Rapid Cool/Emerald/CIM</td>
</tr>
<tr>
<td>13.</td>
<td>Balancing Valves (Water Duty)</td>
<td>Advance / Audco/ L&amp;T/ Honeywell/ Danfoss/ Belimo</td>
</tr>
<tr>
<td>14.</td>
<td>Ball valves (With &amp; W/O Strainers)</td>
<td>Audco /KSB/Advance/ L&amp;T /Zoloto</td>
</tr>
<tr>
<td>15.</td>
<td>Butterfly Valves (Water Duty)</td>
<td>Advance / Audco/ L&amp;T/Zoloto/KSB</td>
</tr>
<tr>
<td>16.</td>
<td>Cable Lugs/Thimbles/Glands</td>
<td>As per Approved Makes of Electrical Works</td>
</tr>
<tr>
<td>17.</td>
<td>Cable Tray</td>
<td>As per Approved Makes of Electrical Works</td>
</tr>
<tr>
<td>18.</td>
<td>CAV Box/VAV Box</td>
<td>Trox/ System Air / Ruskin Titus /Honeywell /Johnson’s Control/Belimo</td>
</tr>
<tr>
<td>19.</td>
<td>Centrifugal Fans/Fan Section/Plug Fans</td>
<td>Kruger / Greenheck /Comefri/ Wolter/ Nicotra/ Systemair/ Airflow</td>
</tr>
<tr>
<td>20.</td>
<td>Check Valve/Foot Valve/Sluice Valve/NRV</td>
<td>Advance / Audco/ L&amp;T/Zoloto/ KSB</td>
</tr>
<tr>
<td>21.</td>
<td>Chilled Water Pump (Primary/Secondary)/ Condenser/Hot Water Pumps etc.</td>
<td>Armstrong /Grundfoss/Xylem -ITT</td>
</tr>
<tr>
<td>22.</td>
<td>Control Cables</td>
<td>As per Electrical Makes</td>
</tr>
<tr>
<td>23.</td>
<td>Cooling Tower</td>
<td>Bell / Paharpur/Flowtech/Baltimore</td>
</tr>
<tr>
<td>24.</td>
<td>CPRX Compound/Tar felt</td>
<td>Shalimar tar product / Asian / Pidilite</td>
</tr>
<tr>
<td>25.</td>
<td>Dry Scrubber</td>
<td>Rydair/ Trion/ Honeywell</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>27.</td>
<td>Electric Motor</td>
<td>ABB/ Siemens/ Crompton Greaves/BALDOR</td>
</tr>
<tr>
<td>29.</td>
<td>Expansion Tank</td>
<td>Xylem-ITT/ Armstrong/ Grundfos/Flamco</td>
</tr>
<tr>
<td>31.</td>
<td>Fan Coil Units with Fans</td>
<td>VTS/Flaktwood/Daikin/Carrier/Johnson Control</td>
</tr>
<tr>
<td>32.</td>
<td>Fasteners-Dash</td>
<td>HILTI/ Fischer/ Cannon/ Wurth</td>
</tr>
<tr>
<td>33.</td>
<td>FCU Copper Connection Set/ FCU Link</td>
<td>ATS/ Oventrop/ CSI</td>
</tr>
<tr>
<td>34.</td>
<td>Filters -Pre/ Fine/ Hepa &amp; BIBO</td>
<td>Thermadyne/ Spectrum/ Camfil/ American Air Filter</td>
</tr>
<tr>
<td>35.</td>
<td>Fire Damper Actuator</td>
<td>Belimo/Siemens/Danfoss/Honeywell</td>
</tr>
<tr>
<td>36.</td>
<td>Fire Dampers / Smoke Dampers</td>
<td>Trox/ Greenheck/Ruskin Titus/Systemair/Airflow</td>
</tr>
<tr>
<td>37.</td>
<td>Flexible Duct Connection</td>
<td>Airflow/Pyroguard/ Rolastar/ UP Twiga</td>
</tr>
<tr>
<td>38.</td>
<td>Flexible Pipe Connection</td>
<td>Resistoflex/ Easyflex/ Diamond/ Dunlop</td>
</tr>
<tr>
<td>39.</td>
<td>FRP lining for condenser piping</td>
<td>Owen-corning/UP Twiga/Binani</td>
</tr>
<tr>
<td>40.</td>
<td>GI/ MS Piping (chilled/condenser/drain/hot)</td>
<td>Jindal-Hissar/TATA/SAIL</td>
</tr>
<tr>
<td>41.</td>
<td>Globe/Gate Valve</td>
<td>Audco/ Advance/ Danfoss/L&amp;T/ KSB/Zoloto</td>
</tr>
<tr>
<td>42.</td>
<td>Heat Recovery Exchanger/ Ventilator/ Wheel</td>
<td>Ostberg/DRI/ Flaktwoods/ Heatex/BryAir</td>
</tr>
<tr>
<td>43.</td>
<td>Hot Water Generators</td>
<td>KEPL/ Rapid cool/ Emerald/ Enmax</td>
</tr>
<tr>
<td>44.</td>
<td>Humidifier</td>
<td>KEPL/ Rapid cool/ Emerald/ Enmax</td>
</tr>
<tr>
<td>45.</td>
<td>Inline Fans</td>
<td>Kruger/ Nicotra/ Greenheck/ Ostberg/Airflow</td>
</tr>
<tr>
<td>46.</td>
<td><strong>Insulation Material</strong></td>
<td></td>
</tr>
<tr>
<td>47.</td>
<td>a) Fiber Glass – Aluminium faced Insulation</td>
<td>UP Twiga/ Owens Corning/ Kimmco</td>
</tr>
<tr>
<td>48.</td>
<td>b) Polyurethane Foam (PUF) Insulation</td>
<td>Styrene Packaging &amp; Insulations/Lloyd Insulations/Supreme</td>
</tr>
<tr>
<td></td>
<td>Item Description</td>
<td>Supplier Options</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------------------</td>
<td>-------------------------------------------------------</td>
</tr>
<tr>
<td>49</td>
<td>c) Nitrile Rubber/EPDM Insulation with antimicrobial</td>
<td>K-Flex/Superlon/Armacell/Supreme</td>
</tr>
<tr>
<td>50</td>
<td>d) XLPE Insulation</td>
<td>Supreme/Vidoflex/Trocellene</td>
</tr>
<tr>
<td>51</td>
<td>e) Expanded Polystyrene Insulation</td>
<td>Styrene Packing/Mettur Beardsell/Toshiba/Trocellin/Thermobreak</td>
</tr>
<tr>
<td>52</td>
<td>Laminar Flow HEPA tent</td>
<td>Systemair/TROX/American Air Filter/Conaire/Thermadyne/Airtech</td>
</tr>
<tr>
<td>53</td>
<td>Magnehelic Gauges</td>
<td>Mitbraus Instruments/Dwyer/Omicron</td>
</tr>
<tr>
<td>54</td>
<td>Paints</td>
<td>As per Civil Works Makes</td>
</tr>
<tr>
<td>55</td>
<td>Pre insulated Ducts</td>
<td>Pal/Zeeco/ALP/Kingspan/Spiro/UP Twiga</td>
</tr>
<tr>
<td>56</td>
<td>Pipe Supports</td>
<td>EASYFLEX/Resistoflex/Diamond</td>
</tr>
<tr>
<td>57</td>
<td>Pipe Supports-PUF</td>
<td>Llyod insulation/Melanpur/Beardsell</td>
</tr>
<tr>
<td>58</td>
<td>Power Cables</td>
<td>As per Electrical Makes</td>
</tr>
<tr>
<td>59</td>
<td>Pressure/Temperature Gauges</td>
<td>H.Guru/Feibig/Warree/H.D.</td>
</tr>
<tr>
<td>60</td>
<td>Propeller Fans</td>
<td>Crompton/Khaitan/Alstom/Bajaj/GE</td>
</tr>
<tr>
<td>61</td>
<td>Thermostat/Humidistat</td>
<td>Honeywell/Johnson/Siemens/Schneider</td>
</tr>
<tr>
<td>62</td>
<td>Purge Valve/Drain Valve</td>
<td>Audco/Advance/Anergy/Zoloto</td>
</tr>
<tr>
<td>63</td>
<td>PVC/uPVC pipe</td>
<td>Polypack/Supreme/Astral/Finolex</td>
</tr>
<tr>
<td>64</td>
<td>Red Oxide/Zinc Chromate Primer</td>
<td>As per Civil Works Makes</td>
</tr>
<tr>
<td>65</td>
<td>Refrigerant Copper Pipes</td>
<td>MANDEV Tubes/Rajco Metal/Mehta Tubes (Max Flow)/Kwality Tubes (Raj State)</td>
</tr>
<tr>
<td>66</td>
<td>Room Thermostat</td>
<td>Honeywell/Johnson/Siemens/Schneider</td>
</tr>
<tr>
<td>67</td>
<td>RP Tissue</td>
<td>UP Twiga/Styrene Packing or equivalent</td>
</tr>
<tr>
<td>68</td>
<td>Split AC Units/Precision AC</td>
<td>Toshiba/Daikin/Hitachi/Carrier</td>
</tr>
<tr>
<td>69</td>
<td>Starters/change over switch/push buttons/Indication Lamps/ Rotary switches/1-phase preventor/Soft starter/MCB/MCCB/ACB/Contactor etc.</td>
<td>As per respective Electrical Makes</td>
</tr>
<tr>
<td>70</td>
<td>Strip Heater</td>
<td>Das Pass/Escorts/KEPL or equivalent</td>
</tr>
<tr>
<td>No.</td>
<td>Item Description</td>
<td>Brand(s)</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>71.</td>
<td>UV &amp; Weather protective Coating</td>
<td>Pidilite / Foster / Amicon</td>
</tr>
<tr>
<td>72.</td>
<td>UVGI System (Ultra Violet Germicidal- Irradiation System)</td>
<td>Ruks / Trimed / Sterile Air</td>
</tr>
<tr>
<td>73.</td>
<td>V Belt</td>
<td>Dunlop / Fenner / Hilton</td>
</tr>
<tr>
<td>74.</td>
<td>Vacuum Degasser</td>
<td>Spirotech / Optivent / Calefi / Comfort / Spirotherm / Flamco</td>
</tr>
<tr>
<td>75.</td>
<td>Variable Frequency Drive</td>
<td>Siemens / Danfoss / ABB / Schneider / L&amp;T</td>
</tr>
<tr>
<td>76.</td>
<td>VRV/ VRF Outdoor / Indoor Units/ Refnet Joints/Remote Controllers</td>
<td>Mitsubishi Electric / Daikin / Toshiba / Panasonic / Carrier</td>
</tr>
<tr>
<td>77.</td>
<td>Chillers</td>
<td>Daikin-Mcquay / Carrier / Trane / York / Dunhambush</td>
</tr>
<tr>
<td>78.</td>
<td>Water Flow Switch</td>
<td>Honeywell / Danfoss / Belimo / Emerald / Rapid Cool</td>
</tr>
<tr>
<td>79.</td>
<td>Vibration Isolators</td>
<td>Easyflex / kanwal / ResistoFlex</td>
</tr>
<tr>
<td>80.</td>
<td>Air Ionizers/ Air Purification System</td>
<td>Plasma / Air / Aerisa / Bentaxna / RGF / Aquaair</td>
</tr>
<tr>
<td>81.</td>
<td>Pot Strainer</td>
<td>Emerald / VTM / Rapid Cool</td>
</tr>
<tr>
<td>82.</td>
<td>Y- Strainer</td>
<td>Zoloto / Audco / Emerald / Rapid cool / Advance</td>
</tr>
<tr>
<td>83.</td>
<td>Chilled Water Cassette Unit</td>
<td>Carrier / TRANE / Daikin / Johnson Control</td>
</tr>
<tr>
<td>84.</td>
<td>Motorized Butterfly Valve</td>
<td>Honeywell / Belimo / Danfoss / Siemens</td>
</tr>
</tbody>
</table>

**IBMS SYSTEM**

<table>
<thead>
<tr>
<th>No.</th>
<th>Item Description</th>
<th>Brand(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Operator Workstation</td>
<td>Dell / Lenovo / HP / IBM</td>
</tr>
<tr>
<td>2.</td>
<td>Printer</td>
<td>Canon / Xerox / HP / Epson</td>
</tr>
<tr>
<td>3.</td>
<td>Network Switch</td>
<td>Cisco / D-Link / HP / Allied Telesis</td>
</tr>
<tr>
<td>4.</td>
<td>Capacitive Touch Panel</td>
<td>Siemens / Honeywell / Schneider / AL C</td>
</tr>
<tr>
<td>5.</td>
<td>BMS Software</td>
<td>Siemens / Schneider / L&amp;T / Honeywell</td>
</tr>
<tr>
<td>6.</td>
<td>System Integration Units</td>
<td>Siemens / Schneider / Johnson Controls / Delta Electronics</td>
</tr>
<tr>
<td>7.</td>
<td>Direct Digital Controller</td>
<td>Honeywell / Siemens / Schneider / L&amp;T</td>
</tr>
<tr>
<td>8.</td>
<td>Immersion Temperature Sensor RTD</td>
<td>Greystone / Honeywell / Siemens / Schneider / Danfoss / L&amp;T</td>
</tr>
<tr>
<td>9.</td>
<td>Outside Air Temperature+ Humidity Sensors</td>
<td>Greystone / Honeywell / Siemens / Schneider / L&amp;T</td>
</tr>
<tr>
<td>No.</td>
<td>Equipment Description</td>
<td>Manufacturer(s)</td>
</tr>
<tr>
<td>-----</td>
<td>------------------------------------------------------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>10.</td>
<td>Ultrasonic Waterflow meter</td>
<td>Kampstrup/Landis+Gyr/Shenitech/Siemens/Honeywell</td>
</tr>
<tr>
<td>11.</td>
<td>Differential Pressure Switches for Air/ Water</td>
<td>Greystone/Honeywell/Siemens/Schneider/L&amp;T/Kele/ALC</td>
</tr>
<tr>
<td>12.</td>
<td>Water Flow Switch</td>
<td>Greystone/Honeywell/Siemens/Schneider/L&amp;T/Weksler/Danfoss</td>
</tr>
<tr>
<td>13.</td>
<td>DP Sensor for Water</td>
<td>Honeywell/Siemens/Schneider/L&amp;T</td>
</tr>
<tr>
<td>14.</td>
<td>pH Analyser</td>
<td>Hach/Omicron/Forbes Marshall</td>
</tr>
<tr>
<td>15.</td>
<td>TDS Analyser</td>
<td>Hach/Omicron/Forbes Marshall</td>
</tr>
<tr>
<td>16.</td>
<td>DP Switch for Filter Status</td>
<td>Honeywell/Siemens/Schneider/L&amp;T</td>
</tr>
<tr>
<td>17.</td>
<td>Air/Water Sensors / Switches / Pressure transmitters / Differential Pressure Switch for Air/Water / Differential Pressure Transmitter</td>
<td>Greystone/Honeywell/Siemens/Schneider/Danfoss/L&amp;T</td>
</tr>
<tr>
<td>18.</td>
<td>Colour Monitor</td>
<td>LG/Samsung/Sony/Phillips</td>
</tr>
<tr>
<td>19.</td>
<td>Communication Cables / Signal Cable</td>
<td>Delton/Fusion Polymer/Skytone/Finolex</td>
</tr>
<tr>
<td>20.</td>
<td>Copper Conductor Control Cable</td>
<td>Same as per Electrical make list</td>
</tr>
<tr>
<td>21.</td>
<td>Current Relay</td>
<td>Same as per Electrical make list</td>
</tr>
<tr>
<td>22.</td>
<td>Duct Mounted Temperature + RH sensor / Duct Temperature Sensor</td>
<td>Greystone/Honeywell/Siemens/Schneider/Danfoss/L&amp;T</td>
</tr>
<tr>
<td>23.</td>
<td>Level Switch / Level Transmitter</td>
<td>Honeywell/Dwyer/Radix/Weksler</td>
</tr>
<tr>
<td>24.</td>
<td>Flow &amp; BTU Meter</td>
<td>Schenitech/Honeywell/Kampstrup</td>
</tr>
<tr>
<td>25.</td>
<td>GI Conduits</td>
<td>Same as per Electrical make list</td>
</tr>
<tr>
<td>26.</td>
<td>LAN cables for BMS Network</td>
<td>Same as per Electrical/LV make list</td>
</tr>
<tr>
<td>27.</td>
<td>MS Conduits</td>
<td>Same as per Electrical make list</td>
</tr>
<tr>
<td>29.</td>
<td>PVC Conduits</td>
<td>Same as per Electrical make list</td>
</tr>
<tr>
<td>30.</td>
<td>Voltage / Current / Power Factor Transducer</td>
<td>L&amp;T/Siemens/Schneider</td>
</tr>
</tbody>
</table>

**SEWAGE/ EFFLUENT TREATMENT PLANT**

<table>
<thead>
<tr>
<th>No.</th>
<th>Equipment Description</th>
<th>Manufacturer(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Air Blowers</td>
<td>Beta/Everest/Kulkarni/TMVT</td>
</tr>
<tr>
<td>2.</td>
<td>Air Diffusion System</td>
<td>Airfin/Usha Ruba/Rehau</td>
</tr>
<tr>
<td>3.</td>
<td>Air Vent Valve</td>
<td>Oven trop (Germany)/CIM/Rapid Control</td>
</tr>
<tr>
<td></td>
<td>Item Description</td>
<td>Make(s)</td>
</tr>
<tr>
<td>---</td>
<td>---------------------------------------------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>4.</td>
<td>Anti Corrosive Tape for Pipe protection</td>
<td>Pypcoat / Marphalt / Cotek/STP</td>
</tr>
<tr>
<td>5.</td>
<td>Ball Valve</td>
<td>Zoloto/Honeywell/RB</td>
</tr>
<tr>
<td>6.</td>
<td>Bar Screen</td>
<td>KSP/AWMS/PAMM</td>
</tr>
<tr>
<td>7.</td>
<td>Blowers</td>
<td>Kay / airvac / Everest</td>
</tr>
<tr>
<td>8.</td>
<td>Butterfly valves</td>
<td>Zoloto/Audco/Kirloskar/AIP/Advance</td>
</tr>
<tr>
<td>9.</td>
<td>Centrifuge</td>
<td>Apollo/United/B.A Engineering</td>
</tr>
<tr>
<td>10.</td>
<td>Check Valve – Dual Plate</td>
<td>Advance/Honeywell/Audco/Zoloto</td>
</tr>
<tr>
<td>11.</td>
<td>Check Valve – Wafer Type</td>
<td>Advance/Danfoss/Zoloto/Honeywell</td>
</tr>
<tr>
<td>12.</td>
<td>Chemical Cleaning Pump</td>
<td>WILO / DP/Grundfos/Xylem</td>
</tr>
<tr>
<td>13.</td>
<td>Chemical Cleaning tank</td>
<td>Polycon / Sintex/Vectus</td>
</tr>
<tr>
<td>14.</td>
<td>Chemical Dosing system</td>
<td>Asia LMI/ Seiko/ E – Dose/ Grundfos</td>
</tr>
<tr>
<td>15.</td>
<td>Dosing Pump</td>
<td>Grundfos / Asia LMI / E-dose / Prominent</td>
</tr>
<tr>
<td>16.</td>
<td>Electrical Panel</td>
<td>As per electrical MAKE LIST</td>
</tr>
<tr>
<td>17.</td>
<td>Epoxy Paint &amp; Paint</td>
<td>Berger / J&amp;N / Asian</td>
</tr>
<tr>
<td>18.</td>
<td>F.R.P Vessel</td>
<td>Pentair / Aventura / Thermax</td>
</tr>
<tr>
<td>19.</td>
<td>Flow Meter (Digital)</td>
<td>Aster (Totalized) / VATS / Scientific</td>
</tr>
<tr>
<td>20.</td>
<td>Flow Rota Meter for Suction Pump</td>
<td>UKL / Aster / Scientific</td>
</tr>
<tr>
<td>21.</td>
<td>Foot Valve</td>
<td>Kirloskar/ Kalpana / Leader/BDK</td>
</tr>
<tr>
<td>22.</td>
<td>G.I. fittings (malleable cast iron)</td>
<td>Unik/ Jain Sons/Zoloto / DRP</td>
</tr>
<tr>
<td>23.</td>
<td>G.I. Pipes/M.S. Pipe</td>
<td>Tata Steel / Jindal / SAIL</td>
</tr>
<tr>
<td>24.</td>
<td>High pressure feed pump.</td>
<td>WILO / DP/Grundfos/Xylem</td>
</tr>
<tr>
<td>25.</td>
<td>Level Controller</td>
<td>Aster/Cirrus Engineering/Rockwell Automation</td>
</tr>
<tr>
<td>26.</td>
<td>Level Indicator</td>
<td>Aster/Cirrus Engineering/Rockwell Automation</td>
</tr>
<tr>
<td>27.</td>
<td>Level Switch</td>
<td>Aster/Cirrus Engineering/Rockwell Automation</td>
</tr>
<tr>
<td>28.</td>
<td>MBR Module</td>
<td>G.E/Siemens/Mitsubishi</td>
</tr>
<tr>
<td>29.</td>
<td>MBR Permeate Suction Pump</td>
<td>WILO / DP/Grundfos/Xylem</td>
</tr>
<tr>
<td>30.</td>
<td>Media</td>
<td>Cooldeck/Usha Ruba/MM Aqua/Pharmatech</td>
</tr>
<tr>
<td>31.</td>
<td>Motor</td>
<td>Siemens/Crompton &amp; Greaves/ ABB</td>
</tr>
<tr>
<td>No.</td>
<td>Material/Component</td>
<td>Manufacturer/Make</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>32.</td>
<td>MSEP Vessel</td>
<td>As per Manufacturer’s standard</td>
</tr>
<tr>
<td>33.</td>
<td>Multiport Valve</td>
<td>Pharer (U.S.A) / ORG/Astar</td>
</tr>
<tr>
<td>34.</td>
<td>Non return valve</td>
<td>Zoloto/Honeywell/RB</td>
</tr>
<tr>
<td>35.</td>
<td>PH Meter</td>
<td>VATS / Hanna/Aster/digital</td>
</tr>
<tr>
<td>36.</td>
<td>Pipe clamp &amp; supports</td>
<td>Chilly/Euroclamp/Kanwal</td>
</tr>
<tr>
<td>37.</td>
<td>PLC / HMI</td>
<td>Schneider / Allen bradley/Mitsubishi</td>
</tr>
<tr>
<td>38.</td>
<td>Pressure Gauges</td>
<td>Waree / H Guru /Fiebeg</td>
</tr>
<tr>
<td>39.</td>
<td>Pressure Switch</td>
<td>Danfoss / Indfoss / Switzer</td>
</tr>
<tr>
<td>40.</td>
<td>Pump Sets i/c Water transfer and sludge disposal/transfer pump</td>
<td>WILO / DP/Grundfos/Xylem/KSB</td>
</tr>
<tr>
<td>41.</td>
<td>Resin</td>
<td>Thermax / Ion Exchange/Auchtel</td>
</tr>
<tr>
<td>42.</td>
<td>Semi Auto Fine Screen</td>
<td>Toro/KSP / AWMS/PAMM</td>
</tr>
<tr>
<td>43.</td>
<td>Sewage &amp; Drainage Submersible Pumps</td>
<td>WILO / DP/Grundfos/Xylem</td>
</tr>
<tr>
<td>44.</td>
<td>Sewage Feed pump</td>
<td>WILO / DP/Grundfos/Xylem</td>
</tr>
<tr>
<td>45.</td>
<td>Strainers</td>
<td>Emerald / Zoloto / Maharaja Casting</td>
</tr>
<tr>
<td>46.</td>
<td>Transfer Pumps</td>
<td>WILO / DP/Grundfos/Xylem</td>
</tr>
<tr>
<td>47.</td>
<td>UV Systems</td>
<td>Alpha UV / Creative UV / Pentair/Eureka Forbes</td>
</tr>
<tr>
<td>48.</td>
<td>VFD</td>
<td>Danfoss/Allen Bredly/Siemens/ABB</td>
</tr>
<tr>
<td>49.</td>
<td>Vibration Eliminator / Anti vibration Mounting</td>
<td>Resistoflex / Kanwal/Banco/Dunlop</td>
</tr>
<tr>
<td>50.</td>
<td>Water Meter</td>
<td>As per Plumbing &amp; Sanitary make list</td>
</tr>
<tr>
<td>51.</td>
<td>Y Strainer</td>
<td>Leader/ Zoloto / Audco/ Castle/Emerald/ Rapid cool</td>
</tr>
</tbody>
</table>

**IPABX & TELEPHONE SYSTEMS**

<table>
<thead>
<tr>
<th>No.</th>
<th>Material/Component</th>
<th>Manufacturer/Make</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Data/ Telephone cable (2/4 /10 / 20/ 50/100 PAIR CABLES)</td>
<td>Delton/ Finolex/ Polycab/ Bonton/ Legrand</td>
</tr>
<tr>
<td>2.</td>
<td>Digital/ANALOG PHONE/Handsets/IP phones</td>
<td>Beetel /Panasonic /Siemens / Alcatel/Cisco /Tadiran</td>
</tr>
<tr>
<td>3.</td>
<td>IPABX Server and Gateways</td>
<td>Alcatel/ Avaya/ Cisco/ Siemens/ Nortel/ Tadiran</td>
</tr>
<tr>
<td>4.</td>
<td>MDF/IDF</td>
<td>Krone/ TVS/ Finolex</td>
</tr>
<tr>
<td>5.</td>
<td>Telephone tag block/Jack Panel/Face Plate</td>
<td>Krone/ Phoenix/ Wago/ Beldon/ Panduit/ Huwaei/ Legrand/Amp</td>
</tr>
<tr>
<td>6.</td>
<td>VOICE BOX – RJII</td>
<td>Krone/ TVS/ Finolex</td>
</tr>
<tr>
<td><strong>DATA NETWORKING &amp; WIFI SYSTEM</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------------</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td><strong>1.</strong> Active Components – Core and Edge Switch</td>
<td>CISCO/ Juniper/ HP/ Dell</td>
<td></td>
</tr>
<tr>
<td><strong>2.</strong> Enclosures – Distribution rack and server rack</td>
<td>APW/ Netrack/ Rittal/ Legrand/ MTS</td>
<td></td>
</tr>
<tr>
<td><strong>3.</strong> Ethernet Switch / Indoor &amp; Outdoor WIFI device/ Transreceivers</td>
<td>CISCO/ JUNIPER/HP</td>
<td></td>
</tr>
<tr>
<td><strong>4.</strong> Routers</td>
<td>ALCATEL/ AVAYA/ CISCO/HP/JUNIPER</td>
<td></td>
</tr>
<tr>
<td><strong>5.</strong> Server</td>
<td>IBM/ Dell/ HP/CISCO</td>
<td></td>
</tr>
<tr>
<td><strong>6.</strong> Firewall</td>
<td>CISCO/ Juniper/HP/Fortinet/Palo Alto</td>
<td></td>
</tr>
<tr>
<td><strong>7.</strong> Passive Components – Cat 6/Cat 6A/ Patch panel/ Patch Cord/ Information outlets/ Optical fiber Cable/ Fiber patch cord/ pigtails/ LIU/ Adapters/ Connectors</td>
<td>Belden/ Simone/ Panduit/ Commscope/ Cisco/ Legrand/ TADIRAN</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Audio Visual System &amp; Stage Lighting System for Auditorium &amp; Conference Rooms</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong> Symmetrical Line Array Speakers, Flying Subwoofers, Loudspeakers, Power Amplifier, Digital Sound Processor, Digital Mixing Console, Microphone, Loudspeaker Cables</td>
<td>L-Acoustics/ Bose/ Martin-Audio/ Labgruppen/ Powersoft</td>
</tr>
<tr>
<td><strong>2.</strong> DVD cum USB Player</td>
<td>Sony/ Philips/ Samsung/ Bose</td>
</tr>
<tr>
<td><strong>3.</strong> Equipment Rack</td>
<td>Rittal/ Netrack/ Cisco/MTS/APW</td>
</tr>
<tr>
<td><strong>4.</strong> PVC Conduits &amp; Raceways</td>
<td>AKG/BEC/ Hensal/ Clipsal/ Polypack/ Precision</td>
</tr>
<tr>
<td><strong>5.</strong> LED Dimmable Lights</td>
<td>Philips/ Wipro/ Havells/ Lutron/Trilux</td>
</tr>
<tr>
<td><strong>6.</strong> LED Signage Board</td>
<td>Wipro/ Philips/ Bajaj/Instapower/Decon</td>
</tr>
<tr>
<td><strong>7.</strong> Video Projector</td>
<td>Christie/ Sony/ Panasonic/Philips</td>
</tr>
<tr>
<td><strong>8.</strong> Projection Screen</td>
<td>Draper/ Da-Lite/ Grandview/ Harkness</td>
</tr>
<tr>
<td><strong>9.</strong> LED Display Monitors</td>
<td>LG/ Sony/ Panasonic/ Philips/Samsung</td>
</tr>
<tr>
<td><strong>10.</strong> Video Conferencing Unit</td>
<td>Sony/ Polycom/ Palco/ Cisco</td>
</tr>
<tr>
<td><strong>11.</strong> HD PTZ Camera, Joystick</td>
<td>Sony/ Palco/Cisco/Bosch/ Panasonic</td>
</tr>
</tbody>
</table>
| **12.** Optical Fibre Cable | Extron/ Kramer/Amp/Belden/ Crestron/ }
<table>
<thead>
<tr>
<th></th>
<th>13. HDMI / VGA Cable</th>
<th>Kramer / Beldon / Klotz</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14. Stage Lighting – Spot Light, Par Light, Flood Light, Dimmer pack, Lighting Console, Splitter, Lamp prism with moving head,</td>
<td>Canara Lighting / Effectron / Stage Technologies</td>
</tr>
<tr>
<td></td>
<td>15. Junction Box</td>
<td>ABB / L&amp;T / Havells / Schneider / Legrand</td>
</tr>
<tr>
<td></td>
<td>16. Curtain Control Panels, Remote Control</td>
<td>Canara Lighting / Effectron / Stage Technologies</td>
</tr>
<tr>
<td></td>
<td>17. RGY Laser</td>
<td>CT Lasers / Canara Lighting / Laser World</td>
</tr>
<tr>
<td></td>
<td>18. Fog Machine, Metal gobos</td>
<td>Antari / Canara Lighting / Robe</td>
</tr>
<tr>
<td></td>
<td>19. Fire Retardant Curtain, Plastic cyclorama screen</td>
<td>Omplie / Raymond / Mayur</td>
</tr>
<tr>
<td></td>
<td>20. Lamps</td>
<td>Osram / Philips / GE / Wipro</td>
</tr>
<tr>
<td></td>
<td>21. DMX Signal Cable for DMX Network</td>
<td>Falcon / Beldon / Polycab / Finolex</td>
</tr>
</tbody>
</table>

### Solid Waste Management System

<table>
<thead>
<tr>
<th></th>
<th>1. Integerated Sterilizer with Shredder</th>
<th>Celitron / Ecodas / Cisa</th>
</tr>
</thead>
</table>

### Note:

1. The contractor will use one of the approved makes as approved by the Engineer – in-charge.
2. In case of different quality / pattern of same make, the pattern / quality shall be approved Engineer – in – charge.
3. For materials / equipment / to be used in items of work for which approved makes are not given herein, the makes of such materials / equipment shall be as decided by Engineer – in-charge.
4. If any major equipment is using a small component of make other than that given as a standard component with the equipment, the same shall be accepted subject to approval of Engineer – in-charge.