Vol.-5: Technical Specifications

ALL INDIA INSTITUTE OF MEDICAL SCIENCES AT
GUWAHATI (ASSAM) UNDER MoHFW

CLIENT
MINISTRY OF HEALTH AND FAMILY WELFARE, GOVT OF INDIA

EXECUTING AGENCY
HITES

ARCHITECTS
CDA
HLL INFRA TECH SERVICES LTD. (HITES)

As

Executing Agency of

MINISTRY OF HEALTH & FAMILY WELFARE

E-Tender

For

“Construction of All India Institute of Medical Sciences

At

Guwahati (Assam), INDIA”

On EPC Basis

Tender No. HITES/AIIMS-GUWAHATI/2018

Volume-5

TECHNICAL SPECIFICATIONS

(October 2018)

B-14 A, SECTOR 62
NOIDA, UP 201 307
Ph.: 0120 4071 500    Fax: 0120 4071 513

www.hllhites.com
Construction of All India Institute of Medical Sciences
At Guwahati (Assam), INDIA on EPC Basis

INDEX

TECHNICAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>General</td>
<td>1</td>
</tr>
<tr>
<td>B.</td>
<td>Technical Specifications - Civil Works</td>
<td>6</td>
</tr>
<tr>
<td>C.</td>
<td>Technical Specifications - Plumbing &amp; Sanitary Works</td>
<td>98</td>
</tr>
<tr>
<td>D.</td>
<td>Technical Specifications - Horticulture Works</td>
<td>145</td>
</tr>
<tr>
<td>E.</td>
<td>List of Approved Makes of Materials - Civil &amp; Plumbing</td>
<td>148</td>
</tr>
<tr>
<td>F.</td>
<td>Technical Specifications – Electrical &amp; Low Voltage Works</td>
<td>156</td>
</tr>
<tr>
<td>G.</td>
<td>Technical Specifications – Diesel Generator Sets &amp; Associated Work</td>
<td>247</td>
</tr>
<tr>
<td>H.</td>
<td>Technical Specifications - Fire Alarm System &amp; PA System</td>
<td>275</td>
</tr>
<tr>
<td>I.</td>
<td>Technical Specifications – Low Voltage System</td>
<td>297</td>
</tr>
<tr>
<td>J.</td>
<td>Technical Specifications - Solar PV System</td>
<td>377</td>
</tr>
<tr>
<td>K.</td>
<td>Technical Specifications - Lifts</td>
<td>398</td>
</tr>
<tr>
<td>L.</td>
<td>Technical Specifications - HVAC System</td>
<td>407</td>
</tr>
<tr>
<td>M.</td>
<td>Technical Specifications - Fire Fighting</td>
<td>563</td>
</tr>
<tr>
<td>N.</td>
<td>Technical Specifications - BMS</td>
<td>588</td>
</tr>
<tr>
<td>O.</td>
<td>Technical Specifications - WTP/STP/ETP/Solar Hot Water System</td>
<td>614</td>
</tr>
<tr>
<td>P.</td>
<td>Technical Specifications - RO Plant</td>
<td>647</td>
</tr>
<tr>
<td>Q.</td>
<td>Technical Specifications – Bio Medical Waste Management System</td>
<td>655</td>
</tr>
<tr>
<td>R.</td>
<td>Technical Specifications – Organic Waste Convertor</td>
<td>657</td>
</tr>
<tr>
<td>S.</td>
<td>List of Approved Makes- Services &amp; Related Works</td>
<td>659</td>
</tr>
<tr>
<td>T.</td>
<td>Technical Specifications – Medical Gas Pipeline System (MGPS)</td>
<td>674</td>
</tr>
<tr>
<td>U.</td>
<td>Technical Specifications – Modular Operation Theatres (MOTs)</td>
<td>687</td>
</tr>
</tbody>
</table>
Construction of All India Institute of Medical Sciences at Guwahati (Assam),
INDIA on EPC Basis

TECHNICAL SPECIFICATIONS (GENERAL)

CHAPTER A

BRIEF OF REQUIREMENT OF THE WORK:

1. Introduction:

The scope of work relates to Construction of All India Institute of Medical Sciences at Guwahati (Assam), India. The work is to be executed Design, Engineering, Procurement & Construction (EPC) basis as laid down in the Master Plan, Concept plans, Design Brief Report and tender drawings including Operation & Maintenance of buildings/services after completion and handing over in phases and up to the expiry of the defect liability period of complete project.

The scope of work shall also include Electrical works, Mechanical works, Electronic works, Plumbing, Sanitary, Sewerage, Storm water drainage, & Fire-Fighting works etc. including maintenance during defect liability period including & 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 replantation etc. to be executed as integral part of the project.

As CLIENT/HITES aims at getting GRIHA 3-Star rating for the building, prospective bidders are required to provide adequate documentation & all other requirements relevant to enable CLIENT/HITES in achieving these objectives as referred above. The following are the salient features of the Works:

a. Foundations & other works like underground water tanks.
b. Super structure
c. Water proofing treatment works
d. Aluminum door and windows, aluminum partition etc.
e. GRC Jali work, White Sandstone façade work, Structural glazing work.
f. Anti-termite chemical treatment
g. Internal and External water supply, Sewerage, Storm water drainage
h. Infrastructure Development i.e. Roads, Parking, Pathways etc.
i. Electrical Installation (Internal & External)
j. Fire Fighting System
k. HT & LT Installation, Substation, DG Sets
l. HVAC & BMS
m. Lifts
n. Fire Alarm, PA, CCTV, EPABX/Telephone, LAN Systems etc.
o. WTP, ETP, STP, R.O System
p. Solar PV, Solar Street Light & Solar Hot Water Systems
q. Signage
r. Landscape & Horticulture Works, Hard Landscaping in Courtyards, Avenues & roundabouts, water bodies etc.
s. Outdoor sports facility.
t. Boundary wall with Entry/Exit gates and security cabins, Internal compound walls
u. Iconic Tower
v. Fire station
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) as mentioned in Schedule ‘F’ of the General Conditions of Contract (GCC). Work under this Contract shall consist of furnishing all labour, materials, equipment, tools & plants and appliances necessary and required.

ii. These Technical Specifications are to be read with the Technical Specifications mentioned in Schedule –F of the General Conditions of Contract. In case of any discrepancy, these technical specifications shall prevail.

iii. The Contractor shall conduct his work, so as not to interfere with or hinder the progress or completion of the work being performed by other Contractor(s) or by the Engineer-in-Charge and shall as far as possible arrange his work and shall place and dispose of the materials being used or removed, so as not to interfere with the operations of other Contractor simultaneously working or he shall arrange his work with that of the others in an acceptable and coordinated manner and shall perform it in proper sequence to the complete satisfaction of others,

iv. 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.

v. No payment shall be made for any damage caused by rain, snowfall, flood or any other natural calamity, whatsoever during the execution of the work. The Contractor shall be fully responsible for any damage to the govt. property and work for which the payment has been advanced to him under the contract and he shall make good the same at his risk and cost. The Contractor shall be fully responsible for safety and security of his material, T&P, Machinery brought to the site by him.

vi. The Contractor shall comply with the safety procedures, norms and guidelines (as applicable) as outlined in the document Part 7 Constructional practices and safety- 2016, National Building code of India, Bureau of Indian Standards. A copy of all pertinent regulations and notices concerning accidents, injury and first-aid shall be prominently exhibited at the work site. Depending upon the scope & nature of work, a person qualified in first-aid shall be available at work site to render and direct first-aid to causalities. A telephone may be provided to first-aid assistant with telephone numbers of the hospitals displayed. Complete reports of all accidents and action taken thereon shall be forwarded to the competent authorities.

vii. The Contractor shall ensure the following activities for construction workers safety, among other measures:
   a. Guarding all parts of dangerous machinery.
   b. Precautionary signs for working on machinery
   c. Maintaining hoists and lifts, lifting machines, chains, ropes, and other lifting tackles in good condition.
   d. Durable and reusable formwork systems to replace timber formwork and ensure that formwork where used is properly maintained.
   e. Ensuring that walking surfaces or boards at height are of sound construction and are provided with safety rails or belts.
   f. Provide protective equipment; helmets etc.
   g. Provide measures to prevent fires. Fire extinguishers and buckets of sand to be provided in the fire-prone area and elsewhere.
   h. Provide sufficient and suitable light for working during night time.

viii. The Contractor shall provide for adequate number of garbage bins around the construction site and the workers facilities and will be responsible for the proper utilization of these bins for any solid waste generated during the construction. The Contractor shall ensure that the site and the workers facilities are kept litter free. Separate bins should be provided for plastic, glass, metal,
biological and paper waste and labeled in both Hindi and English with suitable symbols.

ix. 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.

x. The Contractor shall remove from site all rubbish and debris generated by the Works and keep Works clean and tidy throughout the Contract Period. All the serviceable and non-serviceable (malba) material shall be segregated and stored separately. Malba, rubbish & other waste materials shall be disposed off as directed/ approved by Engineer in Charge and necessary documentations shall be submitted to Engineer-in-charge. In this regard directives of National Green Tribunal or any other authority shall be a binding on Contractor.

xi. Approved Makes:

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 this list. The alternate brand can be used only after the approval of Engineer-in-Charge. The list of approved makes is appended to this document.

xii. Method Statement:

The Contractor shall submit a 'Methods statement' for each important activity for the approval of the Engineer-in-charge soon after the award of work to him. The 'Methods statement' is a statement by which the construction procedures for any activity of construction are formulated and stated in chronological order. The 'Methods statement', should have a description of the item with elaborate procedures in steps to implement the same, the specifications of the materials involved, their testing and acceptance criteria, equipment to be used, Precautions to be taken, etc.

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 bench marks 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 details w.r.t soil strata, bearing capacity etc. given in the DBR are indicative and no claim on the alleged inadequacy or incorrectness of the soil data supplied by the department shall be entertained. The intending Contractor shall conduct soil investigations on their own, and shall be responsible for the adequacy of the design.

4. Coordinated Drawings

i. Before taking up the work, the contractor shall prepare shop drawings for the works listed below for various civil and electrical & other services showing details of lay out in plan including sections & elevations & large scale details and contractor shall plan and mobilize his resources as per these drawings and as per actual site conditions to facilitate convenient execution, installation as well as maintenance of these items.

ii. Shop Drawings:
The scope of work, technical specifications and drawings together shall be considered as a tender requirement and the work shall be carried out as per Good for Construction (GFC) drawings, prepared & submitted by the Contractor and duly approved by Engineer-in-charge. The contractor shall study the GFC drawings and taking into account actual site conditions and selected material and requirements, shall prepare shop drawings as fully coordinated drawings. Such drawings shall be prepared for the works, not limited to the following works:

   a. Aluminium work & Structural glazing.
   b. Expansion joint work
   c. Stone cladding work
   d. Suspended ceiling work, coordinated with all ceiling related services.
   e. Marble, granite, vitreous, ceramic, tile work
   f. All Electrical work
   g. All Sanitary work
   h. All HVAC work
   i. Lifts
   j. Horticulture
   k. Electric Sub-station
   l. DG sets
   m. STP & ETP
   n. CCTV & Access Control
   o. Audio Visual
   p. Boilers & Pumps
   q. Solar panels.
   r. Signages

The shop drawings shall be prepared and submitted for approval well in advance to achieve the milestones provided.

iii. Within the time frame agreed with the Engineer-in-charge, the contractor shall prepare shop drawings using latest version of Auto CAD. Shop drawings shall show all layouts, details in plans & sections showing all connections, junctions, bends, supports, clearances. Fixing arrangements with dimensions room, etc. shall be prepared by the contractor on Auto-CAD based on the architectural drawings and site measurements. All measurable items quantities shall be mentioned on each shop drawing being submitted for approval by the contractor. 3 sets of shop drawings (soft copy also) shall be submitted for approval and Seven sets of final shop drawings after approval by Engineer-in-charge shall be submitted by the contractor along with the soft copy. The shop drawings shall be prepared as per agreed schedule.

iv. Technical submittals of manufacturer’s catalogues and technical data shall be submitted for approval. The contractor shall designate an Engineer responsible for issue and preparation of shop drawings and control of GFC drawings.

5. Scale of Amenities:-
The doors and windows/flooring shall be provided as per the requirements indicated in the finishing schedules/tender drawings/ MOUD Norms for residential buildings and technical specifications. In case of variance, the decision of Engineer incharge shall prevail.

A Chart Listing various Scale of Amenities to be provided in Residential Units shall be as given in the Vol-4, DBR, of tender document.
CHAPTER B

TECHNICAL SPECIFICATIONS- CIVIL WORKS

1 GENERAL

1.1. The work shall be carried out in accordance with the Design Basis Report, 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.

1.2. 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 and plumbing drawings. On completion of work, the Contractor(s) shall submit required number of prints of “as built” drawings to the Engineer-in-Charge.

1.3. Before commencement of any item of work the Contractor shall correlate all the relevant architectural and structural drawings, and specifications etc. and satisfy himself 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.

1.4. 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.

1.5. 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.

1.6. 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.

1.7. 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 shall conform to the samples approved by the Engineer-in-Charge which shall be preserved till the completion of the work.

1.8. 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.

1.9. 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.

1.10. Contractor shall submit minimum “Quality Assurance” plan (in conformity to Clause 1.7 of SCC, Vol-4 ) 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.

d. 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.

e. 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.

f. 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.

g. All the entries in the registers will be made by the designated Engineering Staff of the Contractor.

h. The Contractor shall be responsible for safe custody of all the test registers.

i. 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.

j. 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.

1.11. 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, cast-in-situ mosaic 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.
3 EARTH WORK:

i. The Contractor may note that the works are to be executed in a plot of land recently filled up. The Contractor, at his own cost, shall ensure that proper compaction is achieved, as per requirements and specifications, before construction work is taken up in the respective areas.

ii. For all excavation operations executed manually or by mechanical means, irrespective of the stipulations in the relevant CPWD Specifications or elsewhere in the Contract, the excavated earth shall be put to use in the areas related to the work and thereafter the extra earth shall be used in filling up the low-lying areas of the total plot, at his own cost. If there is any surplus excavated earth thereafter, the same 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.

iii. 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.

iv. Filling in plinth shall be in layers and 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.

v. Handling of C&D Waste :- The debris / building rubbish waste and the like (Construction & Demolition waste commonly known as C & D waste) generated from the work, should be taken out to be disposed it off the campus in a legal and environmental friendly way to the “declared dumping/Land fill sites” where the facility of re-cycling of C&D waste are available. The documentary proof with respect to disposal of all C&D waste generated out of work shall be submitted to Engineer-in-charge on weekly basis.

3.1 Site Clearance:

Before the earth work is started, the area coming under cutting and filling shall be cleared of shrubs, rank vegetation, grass, brushwood, trees and saplings of girth up to 30cm measured at a height of one metre above ground level and rubbish removed / 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 rubbish. The roots of trees and saplings shall be removed to a depth of 60cm below ground level or 30 cm below formation level or 15 cm below sub grade level, whichever is lower, and the holes or hollows filled up with the earth, rammed and levelled.

3.2 Anti-termite treatment:

Anti-termite treatment shall be got done through approved specialized agencies only with prior approval of the Engineer-in-charge or his representative. During the execution of work, if any damage shall occur to the treatment already done, either due to rain or any other circumstances, the same shall be rectified and made good to the entire satisfaction of the CLIENT/ HITES or his representative by the contractor at his costs and risks.

The contractor shall submit a guarantee bond for the anti-termite work executed under the contract in the specified format.

4 PLAIN CEMENT CONCRETE AND REINFORCED CEMENT CONCRETE WORK:

4.1 Stone Aggregate:

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.

4.2 Sand
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.

### 4.3 Cement

i. The contractor shall procure 43 grade Ordinary Portland cement conforming to IS 8112 / Portland Pozzolana Cement conforming to IS 1489 (Part I) as required in the work, from manufacturers as per list of approved makes or from any other reputed cement manufacturer having a production capacity not less than one million tons per annum, in case the cement is not available from manufacturers as per list of approved makes. The bidders may also submit a list of names of cement manufacturers which they propose to use in the work. The bid accepting authority reserves right to accept or reject name(s) of cement manufacturer(s) which the bidder proposes to use in the work.

ii. The supply of cement shall be taken in 50 kg. bags/silos bearing manufacturer’s name and ISI marking. Samples of cement arranged by the Contractor shall be taken by the Engineer-in-charge and got tested in accordance with provisions of relevant BIS codes. In case the test results indicate that the cement arranged by the Contractor does not conform to the relevant BIS codes, the same shall stand rejected, and it shall be removed from the site by the Contractor at his own cost within a week’s time of written order from the Engineer-in-charge to do so. Supply of cement shall be taken in 50-kg bags bearing manufacturer’s name, or his registered trademarks if any and grade and type of cement as well as ISI marking. The packing of the cement bags shall be as per CPWD specifications 2009.

iii. The cement shall be brought at site in bulk supply of approximately 50 tons or more as decided by the Engineer-in-charge. The cement godown of adequate capacity to store the cement shall be constructed by the Contractor at site of work.

iv. The cement godown shall always be accessible for the Engineer-in-Charge or his representative.

v. The cement shall be got tested by the Engineer-in-charge and shall be used on the work only after satisfactory test results have been received. The Contractor shall supply free of charge the cement required for testing including its transportation cost to testing laboratories. The cost of tests shall be borne by the Contractor/Department in the manner indicated below:

a. By the Contractor, if the results show that the cement does not conform to relevant BIS codes.

b. By the Department, if the results show that the cement conforms to relevant BIS codes.

vi. The actual issue and consumption of cement on work shall be regulated and proper accounts maintained as provided in clause 10 of the contract. The theoretical consumption of cement shall be worked out as per procedure prescribed in Clause 42 of the GCC and shall be governed by conditions laid therein. In case the cement consumption is less than the theoretical consumption including permissible variation, recovery at the rate so prescribed shall be made. In case of excess consumption, no adjustment shall be made.

vii. The cement brought to the site and the cement remaining unused after completion of the work shall not be removed from site without the written permission of the Engineer-in-charge.

viii. The damaged cement shall be removed from the site immediately by the Contractor on receipt of a notice in writing from the Engineer-in-charge. If he does not do so within 3 days of receipt of such notice, the Engineer-in-charge shall get it removed at the cost of the Contractor.
4.4 Fly-ash

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 I.S.456-2000 in the items of BMC and RMC. However this shall not override the provisions of the respective items.

4.5 Centering Shuttering and Scaffolding:

All Scaffolding centering for RCC shall be properly designed system and brought to site in sufficient quantity well in advance so that the progress of the work is not hampered for non-availability of the same.

4.6 Reinforcement:

i. The Contractor shall procure TMT bars conforming to IS: 1786 pertaining of Fe500D or Fe 550D Grade from primary steel producers from the list of “Approved make for Civil Works provided in the agreement. The manufacturer has to list a certificate that the material supplied is not a re-rolled product. Relevant vouchers & test certificates will be produced by the contractor. The Contractor shall have to obtain and furnish manufacturer Test Report /test certificates for each dia and each lot Tests to the Engineer-in-charge in respect of all supplies of steel brought by him to the site of work. Re-rolled sections will not be allowed. Reinforcement steel, structural steel shall be stored and stacked in such manner so as to facilitate easy identification, removal etc. The contractor shall take proper care to prevent direct contact between the steel and the ground/water for which he shall provide necessary arrangement at his own cost including ensuring proper drainage of area to prevent water logging as per direction of the Engineer-in-charge. Steel shall also be protected, by applying a coat of neat cement slurry over the bars for which no extra payment shall be made. Test certificates for each consignment of steel shall be furnished and further tests shall be got carried out from the authorized laboratory as per the directions of Engineer-in-charge, before incorporating the materials in the work

ii. 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.

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. Samples shall also be taken and got tested by the Engineer-in-Charge as per the provisions in this regard in relevant BIS codes. In case the test results indicate that the steel arranged by the Contractor does not conform to the specifications as defined the same shall stand rejected, and it shall be removed from the site of work by the Contractor at his cost within a week time or written orders from the Engineer-in-Charge to do so.

vii. For checking nominal mass, tensile strength, bend test & re-bend test etc. specimen of sufficient length shall be cut from each size of the bar at random at frequency not less than the specified below:

<table>
<thead>
<tr>
<th>Size of bar</th>
<th>For consignment below 100 tonnes</th>
<th>For consignment above 100 tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 10 mm dia</td>
<td>One sample for each 25 tonnes or</td>
<td>One sample for each 40 tonnes</td>
</tr>
<tr>
<td>bars</td>
<td>part thereof</td>
<td>tonnes part thereof</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>10 mm to 16mm dia bars</td>
<td>One sample for each 35 tonnes or part thereof</td>
<td>One sample for each 45 tonnes part thereof</td>
</tr>
<tr>
<td>Over 16mm dia bars</td>
<td>One sample for each 45 tonnes or part thereof</td>
<td>One sample for each 50 tonnes part thereof</td>
</tr>
</tbody>
</table>

viii. The Contractor shall supply free of cost the required steel bars for testing. The cost of tests shall be borne by the Contractor.

ix. The actual issue and consumption of steel on work shall be regulated and proper accounts shall be maintained. The theoretical consumption of steel shall be worked out as per procedure prescribed in clause 42 of the GCC and shall be governed by conditions laid therein.

x. Steel brought to site and remaining unused shall not be removed from site without the written permission of Engineer-in-Charge.

xi. Bar Bending Schedule: - Contractor shall prepare bar bending schedules and shall get them approved from the Engineer-in-charge or his authorized representative.

xii. Records of Consumption of Cement & Steel—

a. For the purpose of keeping a record of cement and steel received at site and consumed in works, the contractor shall maintain a properly bound register in the form approved by the Engineer-in-charge, showing columns like quantity received and used in work and balance in hand etc. The contractor’s representative shall sign this register daily.

b. The register of cement & steel shall be kept at site in the safe custody of Engineer-in-charge during progress of the work. This provision will not, however, absolve the contractor from the quality of the final product.

4.7 Concrete Work

All concrete work will be strictly done by automatic computerized batching plant of suitable capacity installed at site or RMC as per approval of HITES / Engineer-in-Charge. No concrete work will be permitted without automatic batching plant unless specifically approved in writing by HITES/ Engineer-in-Charge. All operation required for continuing concreting work at the construction joints for better bond are deemed to be included in the cost and nothing extra shall be payable on this account.

4.8 Transportation, Placing and Compaction of Concrete

i. Transportation of the mix concrete shall be done through transit mixers and concrete pumped through suitable concrete pumps and pipes arrangement and vibrated by vibration machines, materials lifts shall also be provided at site as and where required.

ii. Mixed concrete from the batching plant shall be transported to the point of placement by transit mixers or through concrete pumps or steel closed bottom buckets capable of carrying 6 cum concrete. In case the concrete is proposed to be transported by transit mixer, the mixer speed shall not be less than 4 rev/min. of the drum nor greater than a speed resulting in a peripheral velocity of the drum as 70 m/minute at its largest diameter. The agitating speed of the agitator shall be not less than 2 rev/min. nor more than 6 rev/min. of the drum. The number of revolutions of the mixing drum or blades at mixing speed shall be between 70 to 100 revolutions for a uniform mix, after all ingredients, have been charged into the drum. Unless tempering water is added, all rotation after 100 revolutions shall be at agitating speed of 2 to 6 rev/min. and the number of such rotations shall not exceed 250. The general construction of transit mixer and other requirements shall conform to IS : 5892.

iii. In case concrete is to be transported by pumping, the conduit shall be primed by pumping a batch of mortar / thick cement slurry through the line to lubricate it. Once the pumping is started, it shall not be interrupted (if at all possible) as concrete standing idle in the line is liable to cause a plug. The operator shall ensure that some concrete is always there in the pump-receiving hopper during operation. The lines shall always be maintained clean and shall be free of dents.
iv. Materials for pumped concrete shall be batched consistently and uniformly. Maximum size of aggregate shall not exceed one-third of the internal diameter of the pipe. Grading of aggregate shall be continuous and shall have sufficient ultra-fine materials (materials finer than 0.25mm). Proportion of fine aggregates passing through 0.25mm shall be between 15 & 30% and that passing through 0.125mm sieve shall not be less than 5% of the total volume of aggregate. When pumping long distances and through hot weather, set-retarding admixtures may be used. Admixtures to improve workability can be added. Suitability of concrete shall be through pumping shall be verified by trial mixes and by performing pumping tests.

4.9 RCC Work (Concrete Mix Design)

i. The RCC work shall be done with RMC of Design Mix Concrete, unless otherwise specified. The Ready Mix Concrete shall be as per IS: 4926 and as per CPWD Specification and guide lines. For the nominal mix in RCC, CPWD specification shall be followed. The Design Mix Concrete will be designed based on the principles given in IS: 456, 10262 and SP 23. The contractor shall carry out design mixes for each class of concrete indicating that the concrete ingredients and proportions will result in concrete mix meeting requirements specified. The cement shall be actually weighed as presumption of each bag having 50 kg shall not be allowed. In case of use of admixture, the mix shall be designed with these ingredients as well. The specification as per DBR shall be followed for Design Mix Concrete.

ii. The Engineer-in-Charge will reserve the right to inspect at any stage and reject the concrete if he is not satisfied about quality of product at the user’s end.

iii. The Engineer-in-charge reserves the right to exercise control over the:

a. Ingredients, water and admixtures purchased, stored and to be used in the concrete including conducting of tests for checking quality of materials, recording of test results and declaring the materials fit or unfit for use in production of mix.

b. Calibration check of the plant.

c. Weight and quantity check on the ingredients, water and admixtures 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, if required.

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

v. All required relevant records of produced and used concrete shall be made available to the Engineer-in-Charge or his authorized representative. Engineer-in-Charge shall, as required, specify guidelines & additional procedures for quality control & other parameters in respect of materials, production & transportation of concrete mix which shall be binding on the Contractor. Only concrete as approved in design mix by Engineer-in-Charge shall be produced and transported to the site.

4.10 Concrete Batching Plant (Design Mix)

i. The Concrete Batching Plant of suitable capacity to be installed, as per requirement at site, within a period of 30 days from award of work. The contractor shall install batching plants (preferably within the site or 50 meters distance from the site of work) supplying Concrete at site. The batching plant proposed to be engaged by the contractor shall fulfill the following requirements.

a. It shall be fully computerized.

b. Facility to pump concrete upto the highest point of the building.
c. It should have facility for providing printed advice showing ingredients of concrete carried by each mixer.

d. It should have sufficient capacity to meet the requirement as per schedule.

In case of failure of Batching Plant, RMC may be allowed with a written permission of the Engineer in Charge

ii. Approved admixtures conforming to IS.9103 shall be permitted to be used. The chloride content in the admixture shall satisfy the requirement of BS 5075. The total amount of chloride content in the admixture mixed Concrete shall satisfy the requirement of IS 456-2000.

iii. The concrete mix design with and without admixture will be carried out by the contractor through the Laboratories / Test house as approved by Engineer-in-charge.

iv. The various ingredients for mix design/laboratory tests shall be sent to the lab test house through the Engineer and the sample of such ingredients sent shall be preserved at site by the department till completion of work or change in Design Mix whichever is earlier. The samples shall be taken from the approved materials which are proposed to be used in the work.

v. The batching and mixing plant shall be fully automatic.

vi. The contractor has to arrange to erect batching plant for the design mix concrete on his own.

vii. The concrete shall be transported to the site in specially made Transit Mixers & shall have suitable retarders so that it should not set before placing in position. It should have sufficient flow so that at height the concrete shall be placed by pumping only.

viii. Each Transit Mixer reaching site shall invariably have manufacturer’s certificate containing details like truck number Grade of mix, time of leaving the plant, time of reaching a site etc. A copy of the same shall be handed over to E-in–C or his authorized representative.

ix. However samples for testing etc. shall be taken as per the mandatory tests prescribed in latest CPWD specifications.

x. All cubes shall be tested for 7 days and 28 days tests in conformity with the relevant CPWD specifications.

xi. In the items of RCC walls, railings and roofs etc. nothing extra shall be paid for making designs as per patterns given by Engineer-in-charges or for thickness of sections.

xii. The water will be tested with regard to its suitability for use in CC/RCC work and nothing extra will be paid for on this account.

xiii. Proportioning Concrete

xiv. In proportioning cement concrete, the quantity of both cement and aggregates shall be determined by weight. The cement shall be weighed separately from the aggregates. Water shall either be measured by volume in calibrated tanks or weighed. All measuring equipment shall be maintained in a clean and serviceable condition. The amount of mixing water shall be adjusted to compensate for moisture content in both coarse and fine aggregates. The moisture content of aggregates shall be determined in accordance with IS : 2386 (Part III). Suitable adjustments shall also be made in the weights of aggregates to allow for the variation in weight of aggregates due to variation in moisture content.

xv. Production of Concrete

The concrete shall be RMC produced in a central batching and mixing plant with, computerized printing for contents and admixture dosage. The batching plant shall be fully automatic. Automatic batcher shall be charged by devices which, when actuated by a Single starter switch will automatically start the weighing operation of each material and stop automatically, when the designated weight of each material has been reached. The batching plant shall have automatic arrangement for dispensing the admixture and shall also be capable of discharging water in more than one stage. A print out from the batching plant for every lot shall be submitted. A batching plant essentially shall consist of the following
components: Separate storage bins for different sizes of aggregates, silo for cement; and water storage tank.

a. Batching equipment
b. Mixers
c. Control panels
d. Mechanical material feeding and elevating arrangements
e. The Contractor shall arrange for inspection of automatic batching plant within seven days of issue of letter of award to facilitate inspection and approval of same by Engineer-In-Charge. Nothing extra will be paid for this.

xvi. The compartments of storage bins for aggregates shall be approximately of equal size. The cement compartment shall be centrally located in the batching plant. It shall be watertight and provided with necessary air vent, aeration fittings for proper flow of cement & emergency cement cut off gate. The aggregate and sand shall be charged by power operated centrally revolving chute. The entire plant from mixer floor upward shall be enclosed and insulated. The batch bins shall be constructed so as to by self-cleansing during drawdown. The batch bins shall in general conform to the requirements of IS: 4925.

xvii. The batching equipment shall be capable of determining and controlling the prescribed amounts of various constituent materials for concrete accurately i.e. water, cement, sand, individual size of coarse aggregates etc. The accuracy of the measuring devices shall fall within the following limits.

<table>
<thead>
<tr>
<th>Measurement of Cement</th>
<th>±2% of the quantity of cement in each batch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement of Water</td>
<td>±3% of the quantity of water in each batch</td>
</tr>
<tr>
<td>Measurement of Aggregate</td>
<td>±3% of the quantity of aggregate in each batch</td>
</tr>
<tr>
<td>Measurement of Admixture</td>
<td>±3% of the quantity of admixture in each batch</td>
</tr>
</tbody>
</table>

xviii. Mixing Concrete

The mixer in the batching plant shall be so arranged that mixing action in the mixers can be observed from the operator’s station. The mixer shall be equipped with a mechanically or electrically operated timing, signaling and metering device which will indicate and assure completion of the required mixing period. The mixer shall have all other components as specified in IS: 4925.

4.11 Ready Mix Concrete (RMC)

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 fulfill the following requirements.

a) It shall be fully computerised.

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.

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

iii. 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.

iv. The Engineer-in-Charge reserves the right to exercise check over the:-
a) Ingredients, water and admixtures purchased, stored and to be used in the 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.

v. 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.

vi. 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.

vii. 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:

(i) 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.

(ii) 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 freezing or excessive solar heating of Aggregate etc.

(iii) 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.

(iv) 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.

(v) 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.

(vi) 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.

(vii) Production of Concrete

The following precautions shall be taken during the production of RMC at the plant

a) 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.

b) 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.

c) 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.

d) 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.

e) Sampling of concrete, testing monitoring of results.

f) Diagnosis and correction of faults identified from observations / complaints.

(viii) 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.

a) 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.

b) 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.

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

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

e) 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.

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

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

h) 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 EPC
contractor to arrange requisite quantity of RMC available at site, so that there is no hindrance to the work on this account.

4.12 Standard for Acceptance

i. Standard of acceptance shall be same as specified in clause 16 of IS 456-2000.

ii. In order to keep the floor finish as per direction of Engineer-in-charge and as per Architectural drawings and to provide required thickness of the flooring as per specification, the level of top surface of RCC shall be accordingly adjusted at the time of its centering, shuttering and casting.

4.13 Ultrasonic Pulse Velocity Method of Test for RCC

i. The underlying principle of assessing the quality of concrete is that comparatively higher velocities are obtained when the quality of concrete in terms of density, homogeneity and uniformly is good. The consistency of the concrete as regards its general quality gets established. In case of poorer quality lower velocities are obtained. If there are cracks, voids or flaws inside the concrete which come in the way of transmission of pulse, lower velocities are obtained.

ii. The quality of concrete in terms of uniformity, incidence or absence of internal flaws, cracks and segregation etc. indicative of the level of workmanship employed, can thus be assessed using the guidance given in table below, which have been evolved for characterizing the quality concrete in structure in term of the ultrasonic pulse velocity.

**Velocity criterion for Concrete Quality Grading.**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Pulse velocity by Cross Probing (km/sec)</th>
<th>Concrete Quality Grading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Above 4.5</td>
<td>Excellent</td>
</tr>
<tr>
<td>2</td>
<td>4.5 to 3.5</td>
<td>Good</td>
</tr>
<tr>
<td>3</td>
<td>3.5 to 3.0</td>
<td>Medium</td>
</tr>
<tr>
<td>4</td>
<td>Below 3.0</td>
<td>Doubtful</td>
</tr>
</tbody>
</table>

Note: In Case of "doubtful" quality it may be necessary to carry further tests.

iii. Pulse velocity method of test of concrete is to be conducted for CPWD works as a routine test. The acceptance criteria as per the above table will be applicable which is as per IS 13311 (part-1): 1992. From the above “Good” and “Excellent” grading are acceptable and below these grading the concrete will not be acceptable.

iv. 5% of the total number of RCC members in each category i.e. beam, column, slab and footing may be tested by UPV test method for establishing quality of concrete. It is suggested that test be conducted on RCC beam near joint with column, on RCC column near joint with beam, on RCC footings and rafts. On RCC rafts a suitable grid can be worked out for determining number of tests. In addition doubtful areas such as honeycombed locations, locations, where continuous seepage is observed, construction joints and visible loose pockets will also be tested.

v. The test results are to be examined in view of the above acceptance criteria “Good” and “Excellent” and wherever concrete is found with less than required quality as per acceptance criteria, repairs to concrete will be made. Honeycombed areas and loose pockets will be repaired by grouting using Portland Cement Mortar/Polymer Modifies Cement Mortar /Epoxy Mortar, etc. after chipping loose concrete in appropriate manner. In areas where concrete is found below acceptance criteria and defects are not apparently visible on surface, injecting approved grout in appropriate proportion using epoxy grout /acrylic Polymer modified cements slurry made with shrinkage compensating cement / plain cement slurry etc will be resorted to for repairs.(refer relevant chapters from CPWD Hand Book on Repairs and Rehabilitation of RCC Buildings). Repair to concrete will be done till satisfactory results are obtained as per the acceptance criteria by
retesting of the repaired area. If satisfactory results are not obtained dismantling and relaying of concrete will be done.

4.14 Cover/Spacer Block

The contractor shall provide approved type of support for maintaining the bars in position and ensuring required spacing and correct cover of concrete to reinforcement as called for in the drawings, spacer blocks of required shape and size. Chairs and spacer bars shall be used in order to ensure accurate positioning of reinforcement. Spacer blocks shall be cast well in advance with approved proprietary pre-packed free flowing mortars of high early strength and same colour as surrounding concrete. Pre-cast cement mortar/concrete blocks/blocks of polymer shall not be used as spacer blocks unless specially approved by the Engineer-in-charge.

5 MASONRY WORK

Masonry work shall be carried out in conformity of Latest CPWD Specifications for works.

5.1 BRICK WORK:

Class of Bricks to be used in construction, Grade of Cement Mortar shall be as specified in DBR, Vol-4 and shall be carried out in conformity of Latest CPWD Specifications for works.

5.2 Random Rubble Masonry:

The stone shall be obtained from the quarries, approved by the Engineer-in-Charge. Stone shall be hard, sound, durable and free from weathering decay and defects like cavities, cracks, flaws, sand holes, injurious veins, patches of loose or soft materials and other similar defects that may adversely affect its strength and appearance. As far as possible stones shall be of uniform colour, quality or texture.

Generally stone shall not contain crypt crystalline silica or chart, mica and other deleterious materials like iron-oxide organic impurities etc. Stones with round surface shall not be used. The compressive strength & water absorption shall conform to as per latest CPWD Specification.

The mortar shall be Cement mortar 1:6 (1 cement: 6 Coarse sand), finished with flush/ruled cement pointing.

6 FINISHING:

Plastering, Painting, Polishing/ Varnishing to be carried out as per latest CPWD Specifications and as specified in DBR, Vol-4 (C. Design Basis Report- Civil Works) and finishing schedule/tender drawings.

6.1 Antibacterial Paint

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

ii. 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:

a. 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.

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

c. 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.

7 DOOR & WINDOWS

The doors and windows shall be provided as per the requirements indicated in the Design Brief Report and the respective schedules appended to the Design Basis Report, Finishing Schedule appended with DBR & relevant Tender Drawings. However the typical specifications for the various types of Doors and Windows shall be as under:

7.1 Wooden:

7.1.1 Wood:

a. Timber 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. Kiln seasoning and preservative treatment of wood, if required, shall be done by the contractor. 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.

7.1.2 Glazing:-
The glazing shall be as per CPWD specifications keeping into consideration the size of opening or panels of the glass or as specified.

7.1.3 Pre-laminated Particle Board:-
The pre-laminated particle board shall be off min. 12mm thick and shall be as per CPWD specifications keeping into consideration the size of the opening or as per tender drawings.

7.1.4 Shutters-Wooden-Flush:-

a. Factory made shutters, conforming to IS 2202 (Part –I) 1977, shall be obtained from factories to be approved by the Engineer-in-charge and. 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.

b. 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 contractor shall propose another name of another factory from the approved list for the approval of Engineer-in-charge.

c. 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.

d. The shutters shall be both side laminated with 1mm thick decorative laminated sheet of required make & shade (Factory pressed) or without lamination i.e commercial veneered or decorative veneered as per the finishing schedule & tender drawings appended to the tender document.
7.1.5 Hardware

a. All hardware for doors and windows shall be of stainless steel or as specified. All hardware shall be installed using routers and counter sunk screws. Panic hardware will be provided in all staircase and escape doors. Drawer slides with steel roller ball-bearings and drawer locking system with master keying option is to be provided for all built in cabinetry work and drawer units.

b. The contractor shall procure all the hardware and the fixing shall be done in the best workmanship like manner and in accordance with that employed for fixing hardware.

7.2 Aluminium Works

a. General

i. 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.

ii. 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.

iii. The doors, windows, ventilators, will be fabricated to suit the finished clear openings in the building/structure which the tenderer will himself measure.

b. Materials:

i. The members will be made out of aluminum 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 IS specifications are to be strictly adhered.

iv. The extruder using recycled materials may be preferred.

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

c. Finishing:

i. The extruded aluminum 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/powder coating, as 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/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.

d. Fabrication:
i. Before commencing the fabrication the contractor shall submit to the Engineer – in charge for their approval detailed shop drawings, based on the approved 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 be as per thickness given in the approved shop drawings, Polyester Powder coating / 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.

viii. 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.

e. Glazing:

   The glazing shall be as specified in DBR, Vol-4 & tender drawings or as per CPWD specifications keeping into consideration the size of opening or panels of the glass.

f. Hardware:

   All hardware for doors and windows shall be of Powder coated aluminum or as specified in DBR / tender drawings

g. Fly proof SS wire mesh: Fly proof stainless steel grade 304 wire gauge mesh to be provided in windows and Main Doors entrance doors as specified in Finishing schedule/ tender drawings shall with average width of aperture 1.4 mm in both directions with wire of dia. 0.50 mm all complete

h. Aluminum Grills: Powder Coated Aluminium grill (minimum 50 micron) of approved design/pattern, with approved standard section shall be fixed to the window frame / Door Frame with stainless steel screws @ 200 mm centre to centre, including cutting the grill to proper opening size for fixing and operation of handles and fixing approved aluminium standard section around the opening, all complete as per requirement and direction of Engineer-in-charge.

7.3 Fire Check Doors:-

a. General:-
7.3.1 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 minutes fire rating confirming to BS : 476 part 22 & IS : 3614 Part II.

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

7.3.3 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.

7.3.4 Material: -Door frames and shutter shall be as per DBR/drawings.

7.3.5 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.

7.3.6 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

7.3.7 Opening Width: - Opening width of door mentioned in the drawings shall be width measured with both door shutters fully open in straight position.

7.3.8 Testing: - The Engineer – in - charge holds the right to get the door tested for fire rating at the cost of the contractor. In case the Engineer-in-charge desires to get the doors tested, then one door shall be selected at random out of the entire lot and shall be tested for two hour fire rating. The testing shall be got done from either CBRI, Roorkee or from any other laboratory approved by the Engineer-in-charge. The cost of material for testing and transportation / packing & other incidental testing charges shall be borne by the contractor. In case the door fails to meet the requirement, the entire lot shall be rejected.

b. Wooden Fire Doors & Frames
i. Door Frames: -

Door frame shall be manufactured from 2nd class teakwood (Ivory Coast) of requisite sections. It shall have heat activated intumescent fire seal strip of size 20mm x 4mm (for smoke seal) of approved make provided in grooves on all three sides of the frame. The frame shall be coated with one coat anti-termite fire retardant primer of approved brand. The frame shall be fixed with 8 nos. 100mm dia metal dash fasteners of approved brand and manufacture or as per direction of Engineer-in-charge.

ii. Door Shutter: -

The Door shutter shall be of thickness 50 mm minimum but not more than 55mm, suitable for mounting on the door frame. It shall comprise of two non-combustible boards 12mm to 18 mm thick sandwiching 20 mm to 25 mm fire resistant insulation filler veneered with 3mm thick commercial ply on both faces and pasting of minimum 1 mm thick laminate over wooden fire of approved brand a 100% without Asbestos, Bructile and meerschaum, having density not more than 1150 kg/m3 and thermal conductivity 0.14 W/m K with heat activated intumescent fire seal strip of size 20mm x 4mm of approved mounted in the grooves of teakwood lipping on all sides except bottom.

The intumescent sealant shall be used to fill the gaps between board and internal wooden lipping.

iii. Vision Panel: -
The Fire Rated Glass shall be minimum 11 mm thick interlayred , 120 minutes fire Rated (EW120, EI 15 minutes ) Non Wired, Toughened Interlayered Glass of approved make which can also withstand thermal shock upto 800 degree centigrade shall be used as a glazing (Vision Panel Top(side fixed glazing) and is to be fixed in between the glass beading by using ceramic fiber in accordance with BS : 476 Part 22/ EN 1363 EN 1364 for stability and integrity of size 300 mm x 500mm (Clear vision ) and the manufacturer should have tested the glass of similar or bigger size with any type of door framing from CBRI Roorkee . The Location of the Fr Glass will be as per the directions of Engineer-in-charge.

iv. Finish: 

The door frame and door shutter shall be finished with minimum two or more coats of thermo setting acrylic paint for scratch resistance and durability on hard wooden surface (@3.5 sq.mtr. per ltr., per coat) including preparation of base surface as per recommendation of manufacturer to make the surface fire retardant. The paint shall be of approved brand and quality.

v. Ironmongry Hinges: 

SS Ball Bearing Hinges of size 100 x 75 x 3mm complete with SS Screws of BB1953 Becker F.S / 3090F DORMA / 8011008 GEZE Make ( 4 Nos per panel ) or equivalent approved by Engineer-incharge

c. Metal Fire Doors & Frames: - These shall conform to CPWD specifications.

i. Door Frames: -

Door frame shall be double rebate profile of minimum size 154mm X 77 mm made out of 1.60mm (16gauge) minimum thick galvanized steel sheet. NDRF 154x77 Frames shall be Butt jointed and field assembled with self bolted. The frames should be finished with Thermosetting Powder Coating in desired RAL Shade. All provision should be mortised, drilled and tapped for receiving appropriate hardware. Frames should be provided with back plate bracket and anchor fasteners for installation on a finished plastered masonry wall opening. The frame shall be fixed with 8 nos. 100mm dia metal dash fasteners of approved brand and manufacture or as per direction of Engineer-in-charge.

ii. Door Shutter:

The Door Shutter shall be 50 mm thick glazed fire resistant door shutters of 120 minutes fire rating conforming to IS:3614 (Part-II), tested and certified as per laboratory approved by Engineer-in-charge, with suitable mounting on door frame, consisting of vertical styles, lock rail, top rail 100 mm wide, bottom rail 200 mm wide, made out of 16 SWG G.I.sheet (zinc coating not less than 120 gm/m2) duly filled FR insulation material and fixing with necessary stainless steel ball bearing hinges of approved make, including applying a coat of approved fire resistant primer etc. all complete as per direction of Engineer-in-charge

iii. Vision Panel: -

The Fire Rated Glass shall be minimum 11 mm thick interlayred , 120 minutes fire Rated (EW120, EI 15 minutes ) Non Wired, Toughened Interlayered Glass of approved make which can also withstand thermal shock upto 800 degree centigrade shall be used as a glazing (Vision Panel Top(side fixed glazing) and is to be fixed in between the glass beading by using ceramic fiber in accordance with BS : 476 Part 22/ EN 1363 EN 1364 for stability and integrity of size 300 mm x 500mm (Clear vision ) and the manufacturer should have tested the glass of similar or bigger size with any type of door framing from CBRI Roorkee . The Location of the Fire Glass will be as per the directions of Engineer-in-charge.

iv. Finish: -

The door frame and door shutter shall be finished with minimum two or more coats of thermo setting acrylic paint for scratch resistance and durability on hard wooden surface (@3.5 sq.mtr. per ltr., per coat) including preparation of base surface as
Construction of AIIMS, Guwahati (Assam)  
Vol-Vi: Tech Specs

---

per recommendation of manufacturer to make the surface fire retardant. The paint shall be of approved brand and quality.

v. Ironmongry Hinges:

SS Ball Bearing Hinges of size 100 x 75 x 3mm complete with SS Screws of BB1953 Becker F.S / 3090F DORMA / 8011008 GEZE Make (4 Nos per panel) or equivalent approved by Engineer-in-charge

d. Fire Resistant Glazed Doors, Windows & Partitions:

i. General

The Fire resistant Glazed Doors (hereinafter termed as FRGD), Fire resistant Glazed windows (hereinafter termed as FRGW) and Fire Resistant Glazed Partition (hereinafter termed as FRGP) shall not collapse during the rated period of fire under the specified fire conditions and shall provide safe access to the escape route.

ii. Codes & Specifications

All materials, items, hardware etc. shall be subjected to approval by Engineer-In-Charge. Necessary documentation/test certificates shall be furnished by the Contractor from the manufacturer before supply of material for approval by Engineer-in-charge. Each Door/Window and Partition shall be provided with a small metal identification plate in suitable location indicating Fire rating, name of the Manufacturer, date of installation and details of approved test house. Each Glazing pane shall carry a permanent stamp of the manufacturer.

The complete assembly of the doors i.e. frame, shutter, vision glass and hardware shall have fire rating as required and shall confirm to:

<table>
<thead>
<tr>
<th></th>
<th>EN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EN 1634-1</td>
<td>Fire resistance and smoke control tests for door and shutter assemblies, openable windows and elements of building hardware - Part 1: Fire resistance test for door and shutter assemblies and openable windows</td>
</tr>
<tr>
<td>2</td>
<td>EN 1364-1</td>
<td>Fire resistance tests for non-load bearing elements – Part 1: Walls</td>
</tr>
<tr>
<td>3</td>
<td>EN 410</td>
<td>Determination of luminous and solar characteristics of glazing.</td>
</tr>
<tr>
<td>4</td>
<td>EN 12600</td>
<td>Glass in Buildings – Pendulum test – Impact test and classification for flat glass</td>
</tr>
</tbody>
</table>

iii. Testing & Certification

The FRGD, FRGW & FRGP shall be supplemented with appropriate certification by fire test lab, for applicable or higher dimension with complete description of the architectural components and hardware for FRGD, FRGW and FRGP for which the approval is given. Along with the material tests, the complete system along with the framing shall be tested in accordance with the criteria of EN1634-1 for door/window and EN1364-1 for partition. The installation of the fire rated system shall confirm to requirement of test evidence. The choice of hardware and/or glazed accessories shall be as per test evidence.

iv. Frame for Fire Resistant Glazed Door / Windows

Frame for Door/Window of 120 min fire rating shall be made of section 50 x 60 mm on horizontal side & 35 x 60 mm on vertical sides having built in rebate made out of 1.6 mm thick GI sheet (Zinc coating not less than 120gm/m²) suitable for mounting 120 min Fire Rated Glazed Door Shutters. The frame shall be filled with Mineral wool Insulation having density min 96Kg/m³. The frame will have a provision of GI. Anchor fasteners 14 nos (5 each on vertical style & 4 on horizontal style of size M10 x 80) suitable for fixing in the opening along with Factory made
Template for SS Ball Bearing Hinges of Size 100x89x3mm for fixing of fire rated glazed shutter. The frame shall be finished with a approved fire resistant primer or Powder coating of not less than 30 micron in desired shade as per the directions of Engineer - in-charge. (Cost of SS ball bearing hinges is excluded).

v. **Frame for Fire Resistant Glazed Partitions**

Frame for non-load bearing fixed fire resistant glazed Partition for 120 min Fire Rating shall be made out to a profile of dimension 60mm x 70 mm of 1.6 mm thick galvanised steel sheet as per test evidence suitable for fixing fire rated glass for 120 min of both integrity & radiation control (EW120) & minimum 15 min of insulation (EI15). The profile has to be fixed to the supporting construction by means of anchor fasteners of size M10 x 80, every 150 mm from the edges and every 500 mm (approx) c/c. The frame shall be filled with mineral wool insulation of density min 96kg/m³. and finished with a approved fire resistant primer or Powder coating of not less than 30 micron in desired shade as per the directions of Engineer - in-charge .

vi. **Shutter for Fire Resistant Doors/Windows**

Glazed fire resistant door shutters 60 mm thick of 120 min Fire Rating shall be confirming to IS:3614 (Part II) or EN1634-1:1999, tested and certified as per laboratory approved by Engineer-in-charge, with suitable mounting on door frame, consisting of vertical styles, top rail & side rail 60 mm x 60 mm wide and bottom rail of 110 mm x 60 mm made out of 1.6mm thick G.I. sheet (zinc coating not less than 120gm/m²) duly filled mineral wool insulation having density min 96 kg/m³ and fixing with necessary stainless steel ball bearing hinges of size 100x89x3mm of approved make, including applying a coat of approved fire resistant primer or Powder coating not less than 30 micron etc all complete as per direction of Engineer-in-charge.

vii. **Fire Resistant Glass for Doors/Windows and Partitions**

Glazing to be fixed in fire resistant doors/window shutters and fixed Partitions with G.I. beading made out of 1.6 mm thick G.I. sheet (zinc coating not less than 120 gm/m²) of size 20 x 33 mm screwed with M4 x 38 mm SS screws at distance 75 mm from the edges and 150 mm c/c, including applying a coat of approved fire resistant primer/powder coating of not less than 30 micron on G.I. beading, & special ceramic tape of 5 x 20 mm size etc complete in all respect as per direction of Engineer-in-charge. The glass should be clear, toughened, interlayered, non-wired fire resistant having 11 mm minimum thickness of approved brand with 120 minutes of fire resistance both integrity & radiation control (EW120) and minimum 15 min of insulation (EI15) and having a sound reduction of more than 35dB and LT of 85%. Glass shall be compliant to class 2B2/1B1 category of Impact Resistance as per EN 12600. The glass should be manufactured in UL & TUV audited Facility and including UL-EU Certification. The maximum glazing size cannot be more than 1100 mm x 2200 mm (w x h) or 2.42 sq mts in total area. The test report for the complete system (Glazed Door or Partition) will be considered valid only if it contains the stamp and signature of the authorized signatory from the glass manufacturer.

The complete assembly shall satisfy the given criteria of fire resistance - stability, fire integrity, radiation control and insulation as per above mentioned rating required.

viii. **Vision Panel for Fire Door**

Specifications for glass for Vision panels for Fire Rated Door shall be as per para iv above. The size of glass to be used for vision panels shall be as per tender drawings.

e. **Fire Doors Fittings**
All work is to be carried out in accordance with relevant IS Code and specification for Fire Door & fitting as per IS: 3614 (Part I) – 1966 and direction of Engineer in charge. Door shall be fixed with fire rated hinges 5 Knuckle, 2 bearing butt hinges size 4” x 3” x 3mm, in SS 304 and in satin stainless steel, as per EN 1935, CE Marked.

i. Mortice Lock: - 2 hrs, fire rated mortice lock with lever handle tested in accordance with BS: 476 Part 22. A minimum one year warrantee shall be provided. Mortice sash lock with internal thumb turn and external key operation with lever handles shall be provided.

ii. Flush Bolts (For Double Door):- 300mm concealed extended lever action flush bolts satin finish, fixed to top and bottom of the inactive blade shall be provided.

iii. Automatic Door Closer: - Dual adjustable speed automatic door closer with rack and pinion method, in conformance with BS:476 Part 22 (for fire rating) and BS EN1154 shall be provided. The door closer shall have minimum of one year warrantee.

iv. Pull Handle: 300mm long stainless steel grade 304 D type pull handle shall be fixed with necessary screws etc. complete. A minimum one year warrantee for the product shall be provided.

v. Fire Rated Panic exit device: - It shall be suitable for door weights upto 120kgs. The Panic bar as per door leaf (SINGLE LEAF/DIABLE LEAF) shall consist of Main Panic Latch component, End Component, Push bar, Striker Kit, end caps in Silver finish. Complete set with screws & fixing accessories, External trim, having fire rated door closer TS 71/68 rack and pinion door closer EN size 3/4, with std. arm and with two independent closing valves and latching speed adjustable by arm. Full plastic cover. Silver finish. As per EN 1154 life cycle 500,000 with seals and door stopper. The device shall be complete in all respect and fixed as recommended by the manufacturers. A minimum one year warrantee for the product shall be provided.

vi. Smoke Seals: - Heavy duty smoke seals for smoke check doors shall be provided.

vii. Acoustic Seals: - Acoustic seals of appropriate design duly fixed in shutter as well as door frame shall be provided.

f. Detail of Fire rated Door/Window/Partition

i. Door frames and leaf: 1.6 mm thick GI sheet.

ii. Glazing bead: 1.6 mm thick GI sheet.

iii. Stiffeners: 1.6 mm thick GI sheet.

iv. Glass: Clear toughened interlayer fire rated glass.

v. Beading screw: M4x35 mm @ 150mm (approx.) C/C.

vi. SS ball bearing butt hinges 100x89x3 mm.

vii. Ceramic wool infill (Density – 96 kg/m3)

g. Deliverables by the Contractor

Following documentation/ drawings shall be furnished along with the Doors/ window/ partition.

1) Prototype Test Certificate by national/international test house

2) Shop drawings

3) Specification/ Manufacturer’s literature, Test certificates and other documentation for materials and items intended to be used.

4) Certificate indicating that design and installation of Doors and hardware conforms to norm laid down by approved national/international test house.

5) Test report to be attested by Fire rated glass manufacturer.
6) The Fire rated glass applicator has to be approved by Fire rated Glass Manufacturer has to submit the approved applicator certificate.

7.4 Glazing with Patch Fittings

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, fire-safing 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, 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.

e. Sample for verification, for each type of exposed finish required for
   i. Metal finish: 150mm long section of patch fittings, rails and other items.
ii. Glass: 150mm square, showing exposed edge finish.

f. Materials

i. Glass

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

• 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

• Patch fittings: Stainless steel clad aluminium

• 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.

• Rails: Stainless steel clad aluminium.

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

• Anchors and fastenings: Concealed

• Weather stripping: Sweep type

iii. Hardware

• Hardware should be heavy duty in matching finish

• Concealed Floor Closer and Top Pivots

• Centre hung; BHMA A156.4, Grade 1; including cases, bottom arm, top walking beam pivots, plates, and accessories required for complete installation.

• Swing: Double acting; Positive dead stop, concealed with hold open angle
  Delayed action closing

• Concealed Overhead Holder: Grade 1, with dead stop setting coordinated with concealed floor closer.

• Push-pull set: Stainless steel finish

• Lock set of approved make.

g. Fabrication

i. Provide holes and cutouts 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.

ii. Factory assembled components and factory installed hardware to greatest extent possible.

h. Execution

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

ii. Install all glass system and associated components according to manufacturer’s written instructions.
iii. Set units in level and plumb.

iv. Maintain uniform clearances between adjacent components.

v. Lubricate hardware and other moving parts according to manufacturer's written instructions.

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

i. Cleaning

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

ii. 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.

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

iv. The Contractor shall provide written verification that cleaning agents are compatible with aluminum, 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.

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

vi. 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.

vii. 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.

viii. 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.

ix. 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.

x. 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.

j. Performance Guarantee:

The contractor shall offer a minimum of 10 year Performance Warranty for the entire installation carried out.

7.5 Neutron Shielded Door and Frame-LINAC

a. Material and Fabrication

Borated Polyethylene: minimum of 5% boron content of homogeneous consistency and density throughout polyethylene panel, also available as High Density when fire resistance is required.

1. Sizes: Up to 48” x 96” maximum panel size, or cut to size by manufacturer or by installer.

2. Thickness: 1” thick, or in multiple layers to meet shielding requirements.
b. Door and Frame

Steel Fabrication painted with rust resistant primer finish, and borated polyethylene and lead core as required per the radiation physicist shielding report.

Door Faces: 1/4" thick steel of prime quality cold rolled, pickled carbon steel conforming to ASTM #A366

Door Edges: 1/2" thick steel of prime quality cold rolled, pickled carbon steel conforming to ASTM #A366

Door Core: ___" of 5% Borated Polyethylene (BPE) and ___" pure lead plate per FS QQ-L-201F Grade C.

Reference radiation physicist shielding report for required thickness of borated polyethylene and lead.

c. Hinges: Heavy Duty Full Surface Mounted Hinges of sufficient capacity for total door weight, with adjustable height feature, and bolt on installation with high strength bolts.

d. Frame: 1/4" formed steel to required wall throat thickness single rabbit frame profile, with additional steel reinforcement at hinge locations, welded at mitered corners with internal welded anchors for high density concrete cast in place installation. Frame to be painted with rust resistant primer.

e. Installation

Neutron Shielded Door and Frame and factory pre-hung as a modular unit to be carefully formed and set inplace true, plumb, square, and level by experienced professional concrete tradesmen. Frame and door are to be cast in place with high density concrete of a density as specified by radiation physicist or a minimum 147 lbs per cubic foot dry weight per NCRP or whichever is greater, and free of any voids, butt joints or cold joints. All formed or cast concrete joints must be “keyway” overlapped or interlock type joints.

Built-In Items: Where other built-in items penetrate shielding materials, provide borated polyethylene, neutron putty, and/or lead shielding of same thickness as in surrounding wall partition around door frame as required to maintain continuity of shielding system. Install in strict accordance with manufacturer’s instructions and recommendations.

Finish hardware as specified by Neutron Door Manufacturer.

Surface mounts any utilities when possible. No through penetrations are permitted. All penetrations should be baffled or staggered. Shielding material manufacturer can provide details on proper shielding solutions for various project penetration conditions meeting applicable NCRP requirements. Where recessed outlet boxes, junction boxes, ducts, conduit and similar items prevent the use of shields, provide borated polyethylene, neutron putty or lead sleeves or lead lining or backing as required per radiation physicist report to compensate for displaced concrete or other shielding materials with proper overlaps.

Provide borated shielding materials, lead lining, sleeves, shields and other products of equivalent shielding protection as used in the wall partition shielding system that each penetration occurs in.

Thoroughly HEPA vacuum, clean up and properly recycle all lead trimmings and debris carefully following MSDS instructions. Never dispose of any lead materials in general trash or refuse.

f. Certification

A. Upon completion of Radiation Shielding, the Manufacturer and Fabricator-Installer shall furnish a certificate of compliance stating that all materials provided are in accordance with this specification and the radiation physicist shielding report.

g. Testing
After the intended radiation equipment has been installed and placed in operating condition, and prior to any occupancy and use, the radiation shield

h. Quality Assurance

Standards: Comply with all applicable requirements of National Council on Radiation Protection and Measurement (NCRP) Report No. 147 titled "Structural Shielding and Design Evaluation for Medical Use of X-rays and Gamma Rays of Energies up to 10MeV" and NCRP Report No. 51 "Radiation Protection Design Guidelines for 0.1-100 MeV Particle Accelerator Facilities"

Comply with any applicable requirements of local, state or federal regulatory agencies where building or safety standards or criteria exceed NCRP Report Numbers 49, 51 and 147.

i. Fabricator-Installer Qualifications: Fabricator-Installer shall be experienced in and equipped for work of fabrication and installation equal to standards specified.

8  EXTERNAL FAÇADE WORKS:

8.1 GRC Jali/Paneling

The Glass reinforced concrete (GRC) screens 30mm to 32mm thick and module of 1.5 sqm of approved quality/ pattern shall be synthetic rubber /FRP moulded in size, pattern, design, thickness and colour. The screens made of 53 grade white cement, quartz, fine silica sand, alkali resistant glass fibre, super plasticizer, polymers and UV resistant synthetic inorganic pigments etc. The screen shall be fixed by dry fixing with stainless steel 304 grade "L" shaped cramps, dash fasteners etc. complete. The structural support duly approved shall be provided for GRC jali. The Technical specification of screen shall be as under

- **Dry Density**: > 1800 kg/cum
- **Water Absorption**: Less than 6% of dry weight by immersion over a period of 24 hours.
- **Compressive Strength**: > 400 Kg. / CM² (M - 40 Grade)
- **Wet Transverse Strength**: > 7 N/ mm
- **Abrasion Resistance**: Less than 2.0 for E.H.D.
- **Thermal Conductivity**: 1.63 W/MK at 3% moisture content
  
  1.80 W/MK at 5% moisture content

8.2 Stone work-

8.2.1 Wet cladding:-

The wet cladding shall be laid as per design and in accordance with CPWD Specifications, including SS metal cramps, pins, dowels, ledges and supports, as per design and requirements. The cladding shall be fixed with 12mm thick (minimum), Cement Mortar 1:3 (1cement: 3 coarse sand). Horizontal & vertical joints shall be filled with white cement mixed with pigment of matching shade.

8.2.2 Dry cladding:-

The dry cladding shall be laid as per design with white sandstone 30mm thick gang saw cut stone with (machine cut edges) of uniform colour in sizes as approved by Engineer-In-charge and in accordance with CPWD Specifications, including SS grade 316 or as specified, metal cramps, pins, dowels, ledges and supports, as per design and requirements. The support structure shall be designed by the Contractor and approved by the Engineer-in-charge. Horizontal & vertical joints shall be filled with weather sealant mixed with pigment of matching shade. Groove width, if provided/required, shall be uniform and in plumb of vertical surface.

The contractor shall get this work executed through a specialized agency. The Contractor shall submit the credential of the specialized agency well in advance for verification and only after written approval of Engineer-in-charge can the agency be
deployed for this work. The contractor shall furnish a legal guarantee bond for ten years in prescribed proforma certifying that all the defects noticed during this period shall be rectified and made good to the satisfaction of Engineer-in-charge.

Wherever the stone slab dry cladding is provided exposed to environment, exposed surface and edge surfaces of the stone slabs shall be treated to make the surfaces hydrophobic by applying water repellant / hydrophobic clear coating of water soluble silicate based impregnating agent of approved make. The formulation shall be prepared and applied as per the manufacturer’s recommendations. Before applying the formulation the surface preparation shall be done as per the manufacturer’s recommendations. The surface shall be cleaned using water and the formulation shall be applied on the damp surface. It shall be applied before installation of stone on vertical surface has been completed and after necessary surface preparation.

8.3 Structural Glazing System

a. Scope of Work

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 Design Basis Report & Drawings as given. 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.

b. 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.
• Conceptualising and design of a suitable maintenance system for structural glazing.

c. 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.

d. 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.

e. **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.

f. **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.

g. **Pre Execution Requirements**

i. **Design Proposals**

The contractor shall propose the final design in such a way that all basic functional and architectural requirements in line with the Master Plan, Concept Plans & Design Basis Report are fulfilled and get the same approved by HITES. 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.

two.

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).

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.

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 HITES.

h. 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 Sqm 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 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.

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 Engineer-in-charge 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-curve 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 + 13mm on the Test
Unit (Static Deflection Test).

The dynamic deflection shall be applied up to + 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 litres/m² min. (0.1 gal/sq.ft.).

All water leakage and drainage system at the joint and openable 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. Hold 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 Engineer-in-Charge.

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 HITES.

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 HITES.

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 Engineer-in-Charge’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 Engineer-in-Charge.

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.

i. Performance Guarantee

The tenderer shall provide a performance guarantee as specified in the Specific 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.

9 RAILING, GRILL WORK AND FENCING:

9.1 Grill Work:

a. MS Grills shall be provided in the windows made out of mild steel sections or and as specified in the tender drawings.

b. All steel grills shall be according to the detailed drawings and shall conform to Latest CPWD Specifications.

c. On MS grills an approved quality priming coat of zinc chromate shall be applied over and above a shop coat of primer and finished with two or more coats of low VOC synthetic enamel pain of approved make and shade/ powder coating as specified.

9.2 Railing:

a. MS Railing: As per architectural and structural member including painting & primier coat complete as per CPWD specifications.

b. Stainless Steel Railing

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

ii. 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.

iii. 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.

iv. 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 / HITES. The material shall be procured and the mass work taken up only after the approval of the mock up by the Engineer-in-Charge / HITES. 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.
v. 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.

vi. 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.

vii. 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.

viii. 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.

ix. 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.

x. 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.

xi. 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.

10 STRUCTURAL STEEL

a. General

i. This specification covers the fabrication and transportation to site and erection on prepared foundations and structural steel work consisting of beams, columns, purlins, vertical trusses, bracings, shear connections etc.

ii. Fabrication, erection and approval of steel structures shall be in compliance with General Specifications mentioned in CPWD specifications with up to date correction slips and IS: 800 – 1984. For the guidance on general fabrication and erection of structural steel work, Chapter 11 of IS: 800 (1984) must be followed. As far as safety is concerned guidance could be obtained from Indian safety code for structural steelwork IS: 7205(1974). Before the commencement of the erection, all the erection equipment tools, shackles, ropes etc. should be tested for their load carrying capacity. Such tests if needed may be repeated at intermediate stages also.

iii. Providing shop primer coat for steel structures. Grouting of holding-down bolt pockets and below base plates where required.

b. Scope

The fabrication and erection of the steel work consists of accomplishing of all jobs here-in enumerated including providing all labour, tools and plant all materials and consumables such as welding electrodes, bolts and nuts, oxygen and acetylene gases, oils for cleaning
etc. of approved quality as per relevant IS. The work shall be executed according to the
drawings, specifications, relevant codes etc. in an expeditious and workman like manner,
as detailed in the specifications and the relevant Indian Standard Codes and Standard
Practice and to the complete satisfaction of the Engineer-in-charge.

c. Fabrication Drawings

i. The contractor shall prepare all fabrication and erection drawings on the basis of
approved design drawings and shall submit the same in triplicate to the Engineer-in-
charge for review, Engineer-in-charge shall review and comment, if any, on the same.
Such review, if any, by the Engineer-in-charge, does not relieve the contractor of any
of his required guarantees and responsibilities. The contractor shall however be
responsible to fabricate the structural strictly conforming to specifications and
reviewed drawings.

ii. Fabrication drawings shall include but not limited to the following:

- Member sizes and details
- Types and dimensions of welds and bolts
- Shapes and sizes of edge preparation for welding
- Details of shop and field joints included in assemblies.
- Quality of structural steels, welding electrodes, bolts, nuts and washers etc. to
  be used.
- Erection assemblies, identifying all transportable parts and sub-assemblies,
  associated with special erection instructions, if required.
- Calculations where asked for approval.
- Connections, splices etc. other details not specifically detailed in design
drawings shall be suitably given on fabrication drawings considering normal
detailing practices and developing full member strengths. Where asked for
calculations for the merit shall also be submitted for approval.

iii. Engineer-in-charge review shall not absolve the contractor of his responsibility for the
correctness of dimensions, adequacy of details and connections. One copy will be
returned reviewed with or without comments to the contractor for necessary action. In
the former case further three copies of amended drawings shall be submitted by the
contractor for final review.

iv. The contractor shall supply three prints each of the final reviewed drawings to the
Engineer-in-charge within a week since final review.

v. If any modification is necessary in the approved drawing during the course of
execution of the job, revised fabrication drawings will be prepared by the
contractor, incorporating the changes and the revised fabrication drawings shall be
duly got reviewed as per the above Clauses.

d. Materials

i. Rolled Sections

Structural steel will generally be of standard quality conforming to IS: 226/IS: 2062. Whenever welded construction is specified plates of more than 20 mm
thickness will generally conform to IS: 2062.

ii. Welding Materials

Welding electrodes shall conform to IS: 814 and approval of welding procedures
shall be as per IS: 823.

iii. Bolts, Nuts & Washers

Bolts and nuts shall be as per IS: 1367 and tested as per IS: 1608. It shall have a
minimum tensile strength of 44 Kg/mm2 and minimum elongation of 23% on a
iv. All materials shall conform to their respective specifications. The use of equivalent or higher grade or alternate materials will be considered only in very special cases subject to the approval of the Engineer-in-charge in writing.

v. Receipt & Storing of Materials
- Steel materials supplied by the contractor must be marked for identification and each lot should be accompanied by manufacturer’s quality certificate, conforming chemical analysis and mechanical characteristics.
- All steel parts furnished by supplier shall be checked, sorted out, straightened, and arranged by grades and qualities in stores.
- Structural with surface defects such as pitting, cracks, laminations etc. shall be rejected if the defects exceed the allowable tolerances specified in relevant standards or as directed by the chief Engineer-in-charge.
- Welding wire and electrodes shall be stored separately by qualities and lots inside a dry and enclosed room, in compliance with IS: 816 - 1969 and as per instructions given by the Engineer-in-charge. Electrodes shall be perfectly dry and drawn from an electrode even, if required.

vi. Checking of quality bolts of any kind as well as storage of same shall be made conforming to relevant standards.
- Each lot of electrodes, bolts, nuts, etc. shall be accompanied by manufacturer’s test certificate.
- The contractor may use alternative materials as compared to design specification only with the written approval of the Engineer-in-charge.

vii. Material Tests
- The contractor shall be required to produce manufacturer’s quality certificates for the materials supplied by the contractor. Notwithstanding the manufacturer’s certificates, the Engineer-in-charge may ask for testing of materials in approved test houses. The test results shall satisfy the requirements of the relevant Indian Standards.
- Whenever quality certificates are missing or incomplete or when material quality differs from standard specifications the contractor shall conduct all appropriate tests as directed by the Engineer-in-charge at no extra cost.
- Materials for which test certificates are not available or for which test results do not tally with relevant standard specifications, shall not be used.

viii. Fabrication
The Contractor will submit the credential with full particulars about work completed by fabricator to be deployed for this work for approval of Engineer-in-charge. After written approval is communicated in respect of fabricator, then only the jobs should be assigned to him. Fabrication shall be in accordance with IS: 800 Section V in addition to the following:
- Fabrication shall be done as per approved fabrication drawings adhering strictly to work points and work lines on the same. The connections shall be welded or bolted as per design drawings. Work shall also include fabricating built up sections.
- Any defective material used shall be replaced by the contractor at his own expense, care being taken to prevent any damage to the structure during removal.
• All the fabricated and delivered items shall be suitably packed to be protected from any damage during transportation and handling. Any damage caused at any time shall be made good by the Contractor at his own cost.

• Any faulty fabrication pointed out at any stage of work shall be made good by the contractor at his own cost.

a. Preparation of Materials

Prior to release for fabrication, all rolled sections warped beyond allowable limit shall be pressed or rolled straight and freed from twists, taking care that an uniform pressure is applied. Minor warping, corrugations etc. in rolled sections shall be rectified by cold working. The sections shall be straightened by hot working where the Engineer-in-charge so direct and shall cooled slowly after straightening. Warped members like plates and flats may be used as such only if wave like deformation does not exceed L/1000 but limited to 10 mm (L-Length). Surface of members that are to be jointed by lap or fillet welding or bolting shall be even so that there is no gap between overlapping surfaces.

b. Marking

Marking of members shall be made on horizontal pads, of an appropriate racks or supports in order to ensure horizontal and straight placement of such members. Marking accuracy shall be at least + 1 mm.

c. Cutting

Members shall be cut mechanically (by saw or shear or by oxyacetylene flame). All sharp, rough, or broken edges, and all edges of joints which are subjected to tensile or oscillating stresses, shall be ground. No electric metal arc cutting shall be allowed. All edges cut by oxyacetylene process shall be cleaned of impurities prior to assembly. Cutting tolerances shall be as follows:

a) For members connected at both ends + 1 mm.

b) Elsewhere + 3 mm.

The edge preparation for welding of members more than 12 mm thick shall be done by flame cutting and grinding. Cut faces shall not have cracks or be rough. Edge preparation shall be as per IS : 823 - 1964.

d. Drilling

Bolts holes shall be drilled. Drilling shall be made to the diameter specified in drawings. No enlarging of holes filling, by mandrolling or oxyacetylene flame shall be allowed. Allowed variations for holes (out-of-roundness, eccentricity, plumb-line deviation) shall be as per IS: 800.

- Maximum deviation for spacing of two holes on the same axis shall be + 1 mm.

- Two perpendicular diameters of any oval hole shall not differ by more than 1 mm.

e. Drilling faults in holes may be rectified by reaming the holes to the next upper diameter, provided that spacing of new hole centres and distance of hole centres to the edges of members are not less than allowed and that the increase of hole diameter does not impair the structural strength. Hole reaming shall be allowed if the number of faulty holes does not exceed 15% of the total number of holes for one joint.

f. Welding:

i) Preparation of Members for Welding

• All welding in mild steel work shall be done with electrodes and / or by methods recommended by the suppliers of the metals being welded in accordance with corresponding Indian Standards. Type, size and spacing
of welds, shall be as specified. All welding consumables shall be in accordance with the I.S. standards.

- Welds behind finished mild steel surfaces shall be so done as to eliminate distortion and / or discoloration on the finished side.

- Weld spatter and welding oxides on finished surfaces shall be removed by descaling and / or grinding. Plug, puddle or spot welding shall not be permitted. If weld beads are visible on exposed finished surfaces, the surfaces shall be ground and polished to match and blend with finish on adjacent parent metal.

- Structural welds shall be made by certified welders and shall conform to I.S. code. The welds shall be tested by the Contractor to ensure quality and integrity of the structural welds. However, welding tests shall be carried out as below: and the contractor shall maintain records for Visual testing – 100 % of the welds for size and quality. Fillet weld testing- 30 % of the welds for MPI or Dye penetration test

- Dirt grease, lubricant, or other organic material shall be removed by vapor degreasing or suitable solvent.

- Joints rejected because of welding defects may be repaired only by re welding. Defective welds shall be removed by chipping or machining. Flame cutting shall not be allowed.

ii) Assembly of structural members

Assembly of structural members shall be made with proper jigs and fixtures to ensure correct positioning of members (angles, axes nodes etc.) Sharp edges, rust of cut edges, notches, irregularities and fissures due to faulty cutting shall be chipped or ground or filled over the length of the affected area, deep enough to remove faults completely. Edge preparation for welding shall be carefully and accurately made so as to facilitate a good joint. Generally no special edge preparation shall be required for members under 8 mm thick. Edge preparation (beveling) denotes cutting of the same so as to result in V, X K or U seam shapes as per IS: 823. The members to be assembled shall be clean and dry on the welding edges. Under no circumstances shall wet, greasy, rust or dirt covered parts be assembled. Joints shall be kept free from any foreign matter likely to get in to the gaps between members to be welded. Before assembly the edges to be welded as well as adjacent areas extending for at least 20 mm shall be cleaned (until metallic polish is achieved). When assembling members, proper care shall be taken of welding shrinkage and distortions, as the drawing dimensions cover finished dimensions of the structure. The elements shall be got checked and approved by the Engineer-in-charge or their authorized representative before assembly. The permissible tolerances for assembly of members preparatory to welding shall be as per IS: 823. After the assembly has been checked, temporary tack welding in position shall be done by electric welding; keeping in view finished dimensions of the structure.

iii) Welding procedures

Welding shall be carried out only by fully trained and experienced welders as tested and approved by the Engineer-in-charge. Any test carried out either by the Engineer-in-charge or their representative or the inspectors shall constitute a right by them for such tests and the cost involved thereon shall be borne by the contractor himself. Qualification tests for welders as well as tests for approval of electrodes will be carried out as per IS: 823. The nature of test for performance qualification of welders shall be commensurate with the quality of welding required on this job as judged by the Engineer-in-charge. The steel structures shall be automatically, semi-automatically or manually welded as per direction of Engineer-in-charge. Welding shall begin only after the checks mentioned in Clause herein have been carried out. The welder shall
mark with his identification mark on each element welded by him. When welding is carried out in open air, steps shall be taken to protect the face of welding against wind or rain. The electrodes, wire and parts being welded shall be dry. Before beginning the welding operation, each joint shall be checked to ensure that the parts to be welded are clean and root gaps provided as per IS: 823. For continuing the welding of seems discontinued due to some reason, the end of the discontinued seem shall be melted in order to obtain a good continuity. Before resuming the welding operation, the groove as well as the adjacent parts shall be well cleaned for a length of approx. 50 mm. For single butt welds (in V, 1/2 V or U) and double butt welds (in K, double U etc.) the re-welding of the root is mandatory but only the metal deposit on the root has been cleaned by back gouging or chipping. The welding seams shall be left to cool slowly. The contractor shall not be allowed to cool the welds quickly by any other method. For multi-layer welding, before welding the following layer, the formerly welded layer shall be cleaned metal bright by light chipping and wire brushing. Backing strips shall not be allowed. The order and method of welding shall be so that -

- No unacceptable deformation appears in the welded parts.
- Due margin is provided to compensate for contraction due to welding in order to avoid any high permanent stresses.

The defects in welds must be rectified according to IS: 823 and as per instruction of Engineer-in-charge.

iv) Weld Inspection

The weld seams shall satisfy the following:

- shall correspond to design shapes and dimensions.
- shall not have any defects such as cracks, incomplete penetration and fusion, under-cuts, rough surfaces, burns, blow holes and porosity etc. beyond permissible limits.

During the welding operation and approval of finished elements, inspections and tests shall be made as shown in annexure-B. The mechanical characteristics of the welded joints shall be as in IS: 823.

v) Preparation of Members for Bolting

The members shall be assembled for bolting with proper jigs and fixtures to sustain the assemblies without deformation and bending. Before assembly, all sharp edges, shavings, rust dirt, etc. shall be removed. Before assembly, the contacting surfaces of the members shall be cleaned and given a coat of primer as per IS: 2074. The members which are bolt assembled shall be set according to drawings and temporarily fastened with erection bolts (minimum 4 pieces) to check the co-axiality of the holes. The members shall be finally bolted after the deviations have been corrected, after which there shall not be gaps. Before assembly, the members shall be checked and got approved by the Engineer-in-charge. The difference in thickness of the sections that are butt assembled shall not be more than 3% or maximum 0.8 mm whichever is less. If the difference is larger, it shall be corrected by grinding or filling. Reaming of holes to final diameter or cleaning of these shall be done only after the parts have been check assembled. As each hole is finished to final dimensions (reamed if necessary) it shall be set and bolted up. Erection bolts shall not be removed before other bolts are set.

vi) Bolting up

Final bolting of the members shall be done after the defects have been rectified and approval of joints obtained. The bolts shall be tightened starting from the centre of joint towards the edge.

vii) Planing of Ends
Planing of ends of members like column ends shall be done by grinding when so specified in the design. Planing of butt welded members shall be done after these have been assembled, the spare edges shall be removed with grinding machines or files. The following tolerances shall be permitted on member that has been planed.

- On the length of the member having both ends planed, maximum + 2 mm with respect to design.
- Level differences of planed surfaces, maximum 0.3 mm.
- Deviation between planed surface and member’s axis maximum 1/1500.

viii) Holes for Field Joints

Holes for field joints shall be drilled in the shop to final diameters and tested in the shop, with trial assemblies. When three-dimensional assembly is not possible in the shop, the holes for field joints may be drilled in shop and reamed on site after erection, on approval by the Engineer-in-charge. For bolted steel structures, trial assembly in shop is mandatory. The tolerance for spacing of holes shall be ± 1 mm.

ix) Marking for Identification

All elements and members prior to dispatch from the fabrication yard for erection shall be shop marked. The members shall be visibly marked with a weather proof light coloured paint. The size and thickness of the numbers shall be chosen as to facilitate the identification of members. For the small members that are delivered in bundles or crates, the required marking shall be done on small metal tags securely tied to the bundle, while the crates shall be marked directly. Each bundle or crate shall be packed with members for one and the same assembly; in the same bundle or crate, general utility members such as bolts, quests etc. may be packed. List of materials showing weight, quality and dimension of contents shall be placed in the crates.

The members shall be marked with a durable paint, in a visible location, preferably at one end of the member so that these may be easily checked during storage and erection. All members shall be marked in the shop before inspection and acceptance. When the member is being painted, the marking area shall not be painted but bordered with white paint. The marking and job symbol shall be registered in all shop delivery documents (transportation, for erection etc.)

x) Shop Test Pre-assembly

For steel structures that have the same type of welding the shop test pre-assembly shall be performed on one out of every 10 members minimum. For bolted steel structures, shop test pre-assembly is mandatory for all elements as well as for the entire structure in conformity with previous Clause.

g. Shop Inspection and Approval

i) General

The Engineer-in-charge or their representative shall have free access at all responsible times to the contractor’s fabrication shop and shall be afforded all reasonable facilities for satisfying himself that the fabrication is being undertaken in accordance with drawings and specifications. Technical approval of the steel structure in the shop by the Engineer-in-charge is mandatory. The contractor shall not limit the number and kinds of tests, final as well as intermediate once, or extra tests required by the Engineer-in-charge. The contractor shall furnish necessary tools, gauges, instruments etc. and technical non-technical personnel for shop tests by the Engineer-in-charge, free of cost.

ii) Shop Acceptance
The Engineer-in-charge shall inspect and approve at the following stages:

- The following approvals may be given in shop:
  - Intermediate approvals of work that cannot be inspected later.
  - Partial approvals
  - Final approvals

- Intermediate approval of work shall be given when a part of the work is preformed later:
  - Cannot be inspected later
  - Inspection would be difficult to perform and results would not be satisfactory.

- Partial approval in the shop is given on members and assemblies of steel structures before the primer coat is applied and includes:
  - Approval of materials
  - Approval of field joints
  - Approval of parts with planed surfaces
  - Test erection
  - Approval of members
  - Approval of markings
  - Inspections and approvals of special features, like Rollers, loading platform mechanism etc.

  During the partial approval, intermediate approvals as well as all former approvals, shall be taken into consideration.

  iii) Final approval in the Shop

  The final approval refers to all elements and assemblies of the steel structures, with shop primer coat, ready for delivery from shop to be loaded for transportation, or stored.

  The final approval comprises of:
  - Partial approvals
  - Approval of shop primer coat
  - Approval of mode of loading and transport
  - Approval of storage (for materials stored)

h. Painting and Delivery

  i) Preparation of parts for shop painting: Painting shall consist of providing at least one coat of red oxide zinc chromate primer to steel members before dispatch from shop. Primer coat shall not be applied unless:

  - Surface have been wire brushed, cleaned of dust, oil, rust or sand blasted as per the requirement and direction of Engineer-in-charge etc.
  - Erection gaps between members, spots that cannot be painted or where moisture or other aggressive agents may penetrate, have been filled with an approved type of oil and putty.
  - The surface to be painted is completely dry.
  - The parts where water of aggressive agents may collect (during transportation, storage, erection and operation) are filled with putty and provided with holes for drainage of water.
- Members and parts have been inspected and accepted
- Welds have been accepted.

The following are not to be painted or protected by any other product:
- Surface which are in the vicinity of joints to be welded at site.
- Surfaces bearing markings
- Other surfaces indicated in the design.

The following shall be given a coat of hot oil or any approved resistant lubricant only.
- Planed surfaces
- Holes for links

The surfaces that are to be embedded or in contact with the concrete shall be given a coat of cement wash. The surfaces which are in contact with the ground, gravel or brick work and subject to moisture shall be given bituminous coat. The other surfaces shall be given a primer coating.

Special attention shall be given to locations not easily accessible, where water can collect and which after assembly and erection cannot be inspected, painted and maintained. Holes shall be provided for water drainage and in accessible box type sections shall be hermetically sealed by welds.

The contractor shall paint further coats of red-oxide after erection and placing in position of the steel structures as directed by the Engineer-in-Charge.

ii) Packing, transportation, delivery

After final shop acceptance and marking, the item shall be packed and loaded for transportation. Packing must be adequate to protect item against warping during loading and unloading. Proper lifting devices shall be used for loading, in order to protect items against warping. Slender projecting parts shall be braced with additional steel bars, before loading, for protection against warping during transportation. Loading and transportation shall be done in compliance with transportation rules. If certain parts cannot be transported in the lengths stipulated in the design, the position and type of additional splice joints shall be approved by the Engineer-in-charge. Items must be carefully loaded on platforms of transportation means to prevent warping, bending or falling during transportation. The small parts such as fish-plates, quests etc. shall be securely tied with wire to their respective parts. Bolts, nuts and washers shall be packed and transported in crates. The parts shall be delivered in the order stipulated by the Engineer-in-charge and shall be accompanied by document showing:
- Quality and quantity of structure or members
- Position of member in the structure
- Particulars of structure
- Identification number job symbol.

i. Field Erection

- The erection work shall be permitted only after the foundation or other structure over which the steel work will be erected is approved and is ready for erection.
- The contractor shall satisfy himself about the levels, alignment etc. for the foundations well in advance, before starting the erection. Minor chipping etc. shall be carried out by the contractor on his expense.
• Any faulty erection done by the contractor shall be made good at his own cost.
• Approval by the Engineer-in-charge or their representatives at any stage of work does not relieve the contractor of any of his required guarantees of the contract.
• Storage and preparation of parts prior to erection

The storage place for steel parts shall be prepared in advance and got approved by the Engineer-in-charge before the steel structures start arriving from the hop. A platform shall be provided by the Contractor near the erection site for preliminary erection work. The contractor shall make the following verifications upon receipt of material at site.
- For quality certificates regarding materials and workmanship according to these general specifications and drawings.
- Whether parts received are complete without defects due to transportation, loading and unloading and defects, if any, are well within the admissible limit.

For the above work sufficient space must be allotted in the storage area which will be arranged by the contractor without any extra cost to the department. Steps shall be taken to prevent warping of items during unloading. The parts shall be unloaded, stored and stored so as to be easily identified. The parts shall be stored according to construction symbol and markings so that these may be taken out in order or erection. The parts shall be at least 150 mm clear from ground on wooden or steel blocks for protection against direct contact with ground and to permit drainage of water. If rectification of members like straightening etc. are required, these shall be done in a special place allotted which shall be adequately equipped. The parts shall be clean when delivered for erection.

j. Erection & Tolerances

Erection in general shall be carried out as required and approved by the Engineer-in-charge. Positioning and levelling of the structure, alignment and plumbing of the stanchion and fixing every member of the structure shall be in accordance with the relevant drawings and to the complete satisfaction of the Engineer-in-charge.

The following checks and inspection shall be carried out before during and after erection.
- damage during transportation
- accuracy of alignment of structures
- erection according to drawings and specifications
- progress and workmanship.

There may be any deviations regarding positions of foundations or anchor bolts, which would lead to erection deviations, the Engineer-in-charge shall be informed immediately. Minor rectifications in foundations, orientation of bolts holes etc. shall be carried out as part of the work, at no extra cost. The various parts of the steel structure shall be so erected so to ensure stability against inherent weight, wind and erection stresses. The structure shall be anchored and final erection joints completed after plan and elevation positions of the structural members have been verified with corresponding drawings and approved by the Engineer-in-charge. The bolted joints shall be tightened so that the entire surface of the bolt heads and nuts shall rest on the member. For parts with sloping surfaces tapered washers shall be used.

k. Final acceptance and handing over the structure

(i) At acceptance, the contractor shall submit the following documents:
- Shop and erection drawings – four sets soft copy and hard copies
  4 copies of each of the following:
- Shop acceptance documents quality certificate for structurals, plates, etc.
  (electrodes, welding wire, bolts, nuts, washers etc.)
- List of certified welders who worked on erection of structures.
- Acceptance and intermediate control procedure of erection operations.

(ii) Approval by the Engineer-in-charge at any stage of work does not relieve the contractor of any of his required guarantees of the contract.

1. Grouting of Pockets

(i) Grouting of pockets and under base plates will be done only after the steel work has been levelled and plumbed and the bases of stranchions are supported by steel shims. The space below the base plate and pockets shall be thoroughly cleaned.

(ii) The mortar used for grouting shall not be leaner than 1:2 (1 cement: 2 sand) (grade 300 in case of concrete) or as is specified and shall be mixed to the minimum consistency required. It shall be poured under suitable head and tamped until the space has been completely filled.

m. Tolerances allowed in the erection of building without cranes

The maximum tolerances for line and level of the steel work shall be + 3.00 mm on any part of the structure. The structure shall not be out of plumb more than 3.5 mm on each 10 M. section of height and not more than 7.0 mm per 30 M. section. These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

n. Contractor to submit shop drawing for all structural steel work for approval. The work at site should commence only after getting the shop approved.

o. Contractor to get erection scheme approved before commencement of erection of trusses.

11 FLOORING:

a. The flooring in the building shall be as per the approved finishing schedule appended in DBR, Vol-4/ Tender 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. In order to keep the floor finish as per direction of Engineer-in-charge and as per Finishing Schedule/ Architectural drawings and to provide required thickness of the flooring as per specification, the level of top surface of RCC shall be accordingly adjusted at the time of its centering, shuttering and casting. Alternatively, for maintaining the floor finish, grading with cement concrete with nominal mix 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 10mm nominal size) shall be provided.

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

d. 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.

e. Protective layer to be provided of all types of flooring.

f. The grouting of the joints shall be with white cement and matching pigment.

g. The edges of steps in the staircases, counters, kitchen platform, window sills, facias and similar location shall be edge moulded as required.

11.1 Minimum Bed mortars for various types of flooring
11.1.1 Chequered tiles/stone flooring/kota stone flooring/granite flooring/ Ceramic glazed floor tile flooring/vitrified flooring - 20mm thick bed of cement mortar 1:4 (1 cement: 4 coarse sand). Anti Acid Tiles- 10 mm thick epoxy resin based adhesive.

11.1.2 For dado, skirting and risers of steps in Chequered tiles/stone /kota stone /granite / Ceramic glazed floor tile /vitrified tiles- 12mm thick bed of cement mortar 1:3 (1 cement: 3 coarse sand).

11.1.3 The vertical facia and drops shall be finished with epoxy resin based adhesive.

11.2 Granite Work

The granite stonework shall, in general, be carried out as per the CPWD Specifications and relevant specification for marble flooring, skirting, dado and tread/risers of steps under Flooring Sub Head of the CPWD Specifications shall prevail.

Granite stone slabs shall be pre polished (mirror polished), eggshell polished, flame finished or given any other surface treatment as specified, as per the Engineer-in-charge architectural drawings and as directed by the Engineer-in-Charge. Machine polishing and cutting to required size shall be done with water (as lubricant) only. Sawing shall also be done preferably with water as lubricant but as a special case, the Engineer-in-Charge may permit, at his discretion, oil or kerosene as lubricant subject to all kerosene or oil in the body and surface of tiles / slabs being thoroughly dried in ovens. Tiles / slabs with stains or patches due to the use of oil or otherwise, either before or after installation, shall be rejected and shall be replaced by the Contractor at his own cost. Nothing extra shall be payable on this account.

Before execution of the granite stone work, the contractor shall submit for the approval of the Engineer-in-Charge, the samples with following details:

a) Three representative samples for each type of granite stone specified.

b) Details of physical characteristics such as dimensional tolerances (within the specified limits), water absorption, compressive strength, Mohs Hardness, Specific gravity with reference to IS or International standards.

c) Source of supply and confirmation of availability in full quantity and uniformity of colour, tone and textures.

d) Company profile of Suppliers.

The decision of the Engineer-in-Charge as regards the approval of the samples for the various types of the granite stones shall be final and binding on the Contractor.

The entire supply for each type of granite stone slab shall be procured from one location (in one quarry), and supplied preferably, in one lot to keep variations to the minimum. The Contractor shall also segregate and sort the slabs according to colour, shade, texture and size of grains etc. to keep variation(s) in stones used at any one floor to the minimum. Any slab with variation in the colour, shade, texture and size of grains etc., not acceptable to the Engineer-in-Charge, shall not be used in the work and shall be removed and replaced by the Contractor.

The stone work may be required to be carried out in patterns, design and / or in combination with granite stones of different colour and shade with or without borders and in combination of different stone slabs / ceramic tiles for which nothing extra shall be payable. The stones shall be provided in sizes and shapes as per the approved Engineer-in-charge architectural drawings and wastages and incidental costs, if any, shall be deemed to be covered in the cost of the relevant items. Nothing extra shall be payable on this account.

The following tolerances shall be allowed in the dimension of granite stone slab:

<table>
<thead>
<tr>
<th>Slabs:</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>a). Length</td>
<td>± 1mm</td>
</tr>
<tr>
<td>b). Width</td>
<td>± 1mm</td>
</tr>
<tr>
<td>c). Thickness</td>
<td>- 1mm</td>
</tr>
</tbody>
</table>


**d). Angularity at corners**

± 0.25%

The stones slabs not meeting the above tolerance limits shall be rejected and not permitted to be used in the work. Nothing extra shall be payable on this account.

Stones slabs shall have uniform thicknesses within the tolerance limits and linear items like treads, sills and jambs, coping, risers, urinal partitions, kitchen / wash basin platforms, vanity counters, facias and other similar locations etc. shall have edge polished calibrated thickness i.e. exposed edges shall have edge polished uniform thickness throughout the length of the work.

For the steps (risers and treads) in the linear profile, the granite stone shall be provided in single pieces up to 2.0m, unless otherwise specifically permitted by the Engineer-in-Charge. Wherever grooves are required to be provided the same is to be done, the joints shall be provided.

The granite slabs used for providing and fixing in the sills, soffits and jambs of doors, windows, ventilators and similar locations shall be in single piece unless otherwise directed by the Engineer-in-Charge.

The granite stone slab shall be fixed over low level storage cabinets using necessary adhesive as per the manufacturer’s specification. The stone shall have uniform thickness and shall be provided in sizes as per architectural drawings. The stone slab shall have uniformly levelled surface after fixing. All the joints shall be finished smoothly in a workmanlike manner.

The granite work shall be adequately protected by a layer of Plaster Of Paris, which shall be maintained throughout and removed just before handing over of the works.

### 11.3 Vinyl Flooring:

**a. Vinyl Flooring**

i) Providing and fixing Vinyl Flooring of 2mm thick homogeneous flooring with veined surface pattern and non directional chip texture as per EN649. The tile size should be 615mm x 615mm. The floor should have residual indentation of 0.035mm as per EN 433, the light fastness> 6 as per ISO 105-B02 & electrical resistance should be $5 \times 10^4 < R < 10^6 \Omega$ as per EN 1081 for EC. The product should also confirm to class Bfl-s1 in flammability test as per EN13501-1, slip resistance of R9 as per DIN51130, dynamic coefficient of friction with class DS as per EN 13893. The wear group of Sheet is M as per EN 660-2. Flooring should have excellent chemical resistance as per EN423. The joints to be welded with hot welding coils.

ii) Vinyl flooring as per EN 649, with a 183cm/16-25m sheet width/sheet length, a synthetic floor covering with surface protection. With a thickness of 2mm, it is homogeneous and durable which offers low maintenance. Adhesive to be used is Arobond 44 or equivalent of approved brand and manufacturer. Adhesive must be applied evenly with suitable toothed trowel. Drying time ranges from 24-48 hrs. after installation.

iii) Installation:

It is important to ensure the sub floor on which the sheet is being laid is smooth, flat & hard & free from moisture, grease, etc. In case of uneven sub floor the same should be leveled by self-leveling compound. The moisture level present in the subfloor should be less than 8% before installation of the floor.

The floor shall be laid on a copper strip/foil such that the strip is laid on the perimeter of the room and at the long diagonal of the room. Connection options for the earthing system should be provided at two points in the room, or in larger rooms (over 40 m²) at several points.

The sheet should be laid using water based adhesive like Arobond 44 or similar. Installation should be followed by rolling the sheet with a 45kg roller. The joints should be chord welded with the same color welding rod to have a seamless finish. Post installation maintenance instructions should be followed as per company standards and regular maintenance instructions should be followed to sustain the
life span of the product. The installation shall be undertaken as per the manufacturer’s installation instructions.

b. Conductive Vinyl Flooring:

i) Providing and fixing Conductive Vinyl Flooring of 2mm thick homogeneous flooring with veined surface pattern and non-directional chip texture as per EN649. The tile size should be 615mm x 615mm. The floor should have residual indentation of 0.035mm as per EN 433, the light fastness> 6 as per ISO 105-B02 & electrical resistance should be 5x10^4<R<10^6Ω as per EN 1081 for EC. The product should also confirm to class Bfl- s1 in flammability test as per EN13501-1, slip resistance of R9 as per DIN51130, dynamic coefficient of friction with class DS as per EN 13893. The wear group of Sheet is M as per EN 660-2. Flooring should have excellent chemical resistance as per EN423. The joints to be welded with hot welding coils.

ii) Conductive Vinyl Flooring of 2 mm layer homogeneous flooring with veined surface pattern and non-directional chip texture as per EN649 with 0.2 mm conductive foil backing. The sheet would have an overall thickness of 2.2 mm, width of 1.83 mts & length between 16 to 25 mts. The sheet should have residual indentation of 0.06mm as per EN 433, the color fastness > 6 as per ISO105-B02, vertical resistance < 1X10^6 Ohm as per EN1081 and the static electric charge < 2 kV as per EN1815. The product should also confirm to class Bfl - s1 in flammability test as per EN 13501-1, slip resistance of R10 as per BGR 181, dynamic coefficient of friction with class DS as per EN13893. The wear group of sheet is P as per EN 649.

iii) Installation:

It is important to ensure the sub floor on which the sheet is being laid is smooth, flat & hard & free from moisture, grease, etc. In case of uneven sub floor the same should be leveled by self-leveling compound. The moisture level present in the subfloor should be less than 8% before installation of the floor.

The floor shall be laid on a copper strip/foil such that the strip is laid on the perimeter of the room and at the long diagonal of the room. Connection options for the earthing system should be provided at two points in the room, or in larger rooms (over 40 m²) at several points.

The sheet should be laid using water based adhesive like Arobond 44 or similar. Installation should be followed by rolling the sheet with a 45kg roller. The joints should be chord welded with the same color welding rod to have a seamless finish. Post installation maintenance instructions should be followed as per company standards and regular maintenance instructions should be followed to sustain the life span of the product. The installation shall be undertaken as per the manufacturer’s installation instructions.

11.4 Epoxy Flooring

Epoxy floor coating with a three component solvent base, epoxy resin coating system of approved brand and manufacturer including applying two coats to achieve a total dry film thickness of 90 microns to provide a hard wearing, easily cleaned, attractive floor coating in areas where high resistance to chemical attack is required making sure the time between two coats is 6-24 hrs @ 20degree celcius and 4-16 hours at 35 degree celcius as per manufacturer specifications.

11.5 Tactile Flooring

Fully vitrified unglazed porcelain tile of size 300x300x10mm specially designed to assist the visually impaired- ‘foot Braille’ of approved colour. Conformance with RNIB, DETR & ADA. Very dense, durable and abrasion resistant, high chemical and stain resistant with high strength and durability. Fade proof with low water absorption (below 0.5%) and excellent slip resistance.

11.6 Flooring for SERVER/ EPABX/ Fire Control/ CCTV Room
Removable raised/ false access flooring with system and its components of approved make for 300/450 mm height with possible height adjustment conforming to CPWD Specifications.

11.7 Carpet Flooring (Auditorium)

Flocked floor covering rolls or equivalent having a density of 70 million fibers of nylon 6.6 per sqm , Appearance Retention Hexapod ISO 140-8, Friction Slip Resistance Test EN 14041 Class DS, sanitized anti-microbial treatment with resilient waterproof backing , anti-allergic certified by British allergy foundation, anti-static, thickness 6 mm and approximate weight of 1.8 k.g./sqm of roll form. The resistance to fire should be as per EN 13501-1: Bfl-s1. shade as approved by client and installed by approved applicator of manufacturer. Flocked flooring should be installed over CC flooring as per manufacturer specification and directions of Engineer in charge.

11.8 Wooden Laminated Flooring.

The wooden laminates shall be 11mm thick conforming to EN 13329, ASTM C 1028, DIN 52185, DIN 54345, EN 717-2, DIN 4102. matt finish of required shade - with inbuilt 3mm Sound Bloc - Class of use 34/23, wear resistance AC - 5, impact resistance -IC 3, (as per EN 13329), having 0.6mm MLC (Multi-Layer Composite) high pressure laminate, surface treated with (Aluminum Oxide) surface guard + and SRSG2 (Scratch resistance surface second generation) on top of Moisture Resistant High Density Fibre Board substrate specially developed core; of plank size minimum 1196 mm x 196 mm having click system joints tongue and groove to secure long lasting joint, the tongue and groove having the edges duly pre impregnated with paraffine and laid over underly of 0.2mm thick Alkali Resistant Polyethylene Sheet (Density 920-935 kg/Cum) complete as per manufacturers specifications and direction of Engineer-in-Charge.

Hardwood Flooring if specified shall be carried out as per CPWD Specifications

12 FALSE CEILING

12.1 General: -

a. The false ceiling in the buildings shall be as per the approved finishing schedule appended in DBR, Vol-4/ tender drawings as per latest CPWD specifications or manufactures specifications.

b. False ceiling items in general are carried out as per the manufacturer’s specifications / as directed by the Engineer – in – Charge.

c. 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.

d. The false ceiling tiles from manufacturers using recycled materials shall be preferred.

e. Trap doors, as required, of approved size and design shall be provided.

12.2 Mineral Fibre Ceiling Tile

a. 16 mm Mineral Fibre ceiling Tile

i. Material

Ceiling tiles shall be of made of mineral fibre of dimension 595x595mm with 16 mm thickness humidity resistance 99% Thermal conductivity $K = 0.052-0.057 \text{ w/mK}$ colour white, fire performance UK Class 0/Class 1 (BS 476 pt -6&7) suitable for green building application (GRIHA Criteria 17 & 29 SWAGRIHA 12) with recycled content not less than 30 % and light reflectance not less than 85%. NRC of 0.55 to 0.6. The tile and grid should carry a limited warranty of one year against sag.

ii. Frame

The frame work shall consist of G.i. ' T ' Sections for Main runners 15x38x3000mm length, Cross runners of 15x32x1200mm & 15x32x600mm size, 0.33 mm thickness as specified in the item with galvanization of 120 gsm (minimum) and perimeter
ii. **Fixing of Ceiling Tiles**

The frame work shall be suspended from ceiling by L shape level adjuster hangers made of G.I. Of size 85x25x25x2mm having die cut slit for sliding into main T section, also having precut hole so that 6mm fully threaded MS rod length upto 1000mm goes through it and pierces into M6 dash fasteners (Galvanising of 80 gsm minimum) of 6 mm dia 50mm long, fixed to the slab and then tightened with check nuts, subsequently the bottom of 6 mm rod will be tightened with check nuts for adjusting the line & level. The tile shall be laid on 15x32mm wide T section flanges colour white having rotary stitching on all T sections i.e. the main runner, 1200 mm & 600 mm cross Tees with a web height of 32 mm and load carrying capacity of 7.57Kgs/m2. The fixing arrangement shall be as per CPWD specifications / Manufacturer’s specifications.

b. **20mm Mineral Fibre Ceiling Tile**

General specification for providing and fixing mineral fibre false ceiling tiles item to be same as mentioned in para i. to v. of para a. above except the thickness of mineral fibre tile will be 20 mm and NRC value 0.7.

c. **16mm Antimicrobial Ceiling Tile**

General specification for providing and fixing 16 mm thick beveled tegular mineral fibre false ceiling tiles item to be same as mentioned in para i. to iii. of para a. above except the tile will be Anti-microbial false ceiling tiles.

d. **20mm Mineral Fibre Ceiling Tile**

General specification for providing and fixing mineral fibre false ceiling tiles item to be same as mentioned in para i. to iii. of para a. above except the thickness of mineral fibre tile will be 20 mm and NRC value 0.7.

e. **16mm Antimicrobial Ceiling Tile**

General specification for providing and fixing 16 mm thick beveled tegular mineral fibre false ceiling tiles item to be same as mentioned in para i. to iii. of para a. above except the tile will be Anti-microbial false ceiling tiles.

12.3 **Light Weight Calcium Silicate False Ceiling Tiles**

a. **15mm Tegular edged light weight calcium silicate false ceiling tiles**

i. **Material**

15 mm thick tegular edged light weight calcium silicate false ceiling tiles with integral densified calcium silicate reinforced with fibre and natural filler false ceiling tiles of Size 595x595 mm of approved texture, design and patterns having NRC (Noise Reduction coefficient) of 0.50 (minimum) as per IS 8225:1987, Light reflectance of 85% (minimum). Non-combustible as per BS: 476 (part-4), fire performance as per BS:476 (part 6 &7), humidity resistance of 100%, thermal conductivity <0.043 W/mK as per ASTM 518:1991. The tests shall have average density of 370 kg/m3 (minimum) as per ECBC code 2007. The tile shall be primer coated on both sides and the fair surface shall be having a factory finish in two coats of white dispersion type solvent free paint.

ii. **Frame**

The frame work shall consist of G.I. ‘T’ Sections for Main runners 24x38x3000mm length, Cross runners of 24x32x1200mm & 24x32x600mm size, 0.33 mm thickness as specified in the item with galvanisation of 120 gsm (minimum) and
perimeter wall angle of 0.40mm (minimum) thick gauge having equal flanges of size 24x24mm made from precoated G.I. Coil length of 3.0m fixed to the wall with the help of plastic rawl plugs at 450mm centre to centre with 40mm long dry wall SS screws. The frame work shall be executed in a manner so as to form a grid of 600x600mm as specified in the item.

iii. Fixing of Ceiling Tiles

The frame work shall be suspended from ceiling by L shape level adjuster hangers made of G.I. Of size 85x25x25x2mm having die cut slit for sliding into main T section, also having precut hole so that 6mm fully threaded MS rod length upto 1000mm goes through it and pierces into M6 dash fasteners (Galvanising of 80 gsm minimum) of 6 mm dia 50mm long, fixed to the slab and then tightened with check nuts, subsequently the bottom of 6 mm rod will be tightened with check nuts for adjusting the line & level. The tile shall be laid on 24x32mm wide T section flanges colour white having rotary stitching on all T sections i.e. the main runner, 1200 mm & 600 mm cross Tees with a web height of 32 mm and load carrying capacity of 7.57Kgs/m².

b. 15mm thick integral densified micro edged light weight calcium silicate false ceiling tiles

i. Material

15mm thick integral densified micro edged light weight calcium silicate false ceiling tiles with integral densified calcium silicate reinforced with fibre and natural filler false ceiling tiles of Size 595x595 mm of approved texture, design and patterns having NRC (Noise Reduction coefficient) of 0.50 (minimum) as per IS 8225:1987, Light reflectance of 85% (minimum). Non combustible as per BS:476 (part-4), fire performance as per BS:476 (part 6 & 7), humidity resistance of 100%, thermal conductivity <0.043 W/mK as per ASTM 518:1991. The tests shall have average density of 370 kg/m³ (minimum) as per ECBC code 2007. The tile shall be primer coated on both sides and the fair surface shall be having a factory finish in two coats of white dispersion type solvent free paint.

ii. Frame

The frame work shall consist of G.I. ' T ' Sections of 25 micron hot dipped galvanised iron section of 0.40mm thick on Silhouette profile, rotary stitched double webbed white with 6mm reveal profile (white/black) compromising of Main runners 15x42x3000mm length, Cross runners of 15x42x1200mm & 15x42x600mm size to form grid module of size 600x600mm. Galvanised iron perimeter wall angle of size 22x19x0.4mm of length 3000mm to be fixed on periphery wall/partition with the help of plastic rawl plugs at 450mm C/C and 40mm long dry wall SS screws. The work shall be carried out as per specifications, drawing and as per direction of Engineer-in-Charge.

iii. Fixing of Ceiling Tiles

The frame work shall be suspended from ceiling by L shape level adjuster hangers made of G.I. Of size 85x25x25x2mm having die cut slit for sliding into main T section, also having precut hole so that 6mm fully threaded MS rod length upto 1000mm goes through it and pierces into M6 dash fasteners (Galvanising of 80 gsm minimum) of 6 mm dia 50mm long, fixed to the slab and then tightened with check nuts, subsequently the bottom of 6 mm rod will be tightened with check nuts for adjusting the line & level. The tile shall be laid on 15x42mm wide T section flanges colour white having rotary stitching on all T sections i.e. the main runner, 1200mm & 600mm cross Tees with a web height of 42 mm and load carrying capacity of 7.57Kgs/m².

c. 15mm Tegular/integral densified micro edged Light weight calcium silicate false ceiling tiles

12.4 Under Deck Insulation- Glass Wool Insulation Board
a. **Material:** The under deck insulation shall be with Glass Wool Insulation Board. The Glass Wool Board shall conform to following specifications.

### GLASS INSULATION WOOL BOARD (GREEN BUILDING)

<table>
<thead>
<tr>
<th>Test Parameters</th>
<th>Standard Value</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Physical Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Visual Appearance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Shots Content</td>
<td>Free from Shot Content (Tested as per IS : 8183)</td>
<td></td>
</tr>
<tr>
<td>c. Dimensions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>1200 mm</td>
<td>+20 mm/ -10 mm</td>
</tr>
<tr>
<td>Width</td>
<td>600 mm</td>
<td>+10 mm/ -10 mm</td>
</tr>
<tr>
<td>Thickness</td>
<td>100mm</td>
<td>+5 mm/ -5 mm</td>
</tr>
<tr>
<td>d. Bulk Density</td>
<td>48 Kg/M³</td>
<td>± 15%</td>
</tr>
<tr>
<td>e. Hydrophobic / Non Hydrophobic Behavior (Tested as per Is – 8183 / 3144)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Moisture Content</td>
<td>2.0% Max</td>
<td></td>
</tr>
<tr>
<td>ii. Moisture Absorption</td>
<td>2.0% Max</td>
<td></td>
</tr>
<tr>
<td>f. Incombustibility</td>
<td>Incombustible When Tested As Per Is 818 / 3144</td>
<td></td>
</tr>
<tr>
<td>g. Recovery after Compression</td>
<td>90% Min. (Tested As Per Is -8183)</td>
<td></td>
</tr>
</tbody>
</table>

2. **For Long Life Functionality / Dimension Retention / Rigidity**

<table>
<thead>
<tr>
<th>Test Parameters</th>
<th>Standard Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Loss on Ignition (Binder Content)</td>
<td>Av. 7% Minimum when evaporated at 550 ± 50 till yellow &amp; black colourless fiber achieved</td>
</tr>
<tr>
<td>b. Jolting Test</td>
<td>Height settlement not more than 3.0% in test as per IS: 8183/3144</td>
</tr>
<tr>
<td>c. Vibration Test</td>
<td>Height settlement not more than 1.0% in test as per IS: 8183/3144</td>
</tr>
</tbody>
</table>
| d. Recycled Content | • 25% External Cullet  
                          • 10% Internal Cullet  
                          • 7% Trimmed Waste |

3. **Chemical Test :- Resistance To Corrosion Attack**

<table>
<thead>
<tr>
<th>Test Parameters</th>
<th>Standard Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Chloride Content %</td>
<td>0.01% max. (tested as per IS: 8183)</td>
</tr>
<tr>
<td>b. Alkalinity</td>
<td>Ph- 7.0 – 10.0 (tested as per IS: 8183)</td>
</tr>
<tr>
<td>c. Odour Emission Test</td>
<td>No apparent difference in odour(tested as per IS: 8183- 1993)</td>
</tr>
</tbody>
</table>

4. **Type Test**

<table>
<thead>
<tr>
<th>Test Parameters</th>
<th>Standard Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Thermal Conductivity</td>
<td>0.3 w/m k (At 25 dg. C mean temp.)</td>
</tr>
</tbody>
</table>

b. **Installation Guidelines:**

i. The insulation board to be fixed to hold against the RCC true ceiling.
ii. For fixing drill RCC slab through the insulation at 1200 mm x 600 mm centres.

iii. Apply the Hilti make IDP- 6/8 polyamide fasteners (110 mm in length) or equivalent with the help of hammer to the drilled points.

iv. All the edges of the boards placed side by side to be sealed with 50 mm wide self-adhesive white HDP tape.

v. The above insulation system can be concealed under false ceiling system if required.

12.5 Under Deck Insulation System-Polystyrene Rigid Insulation Board

a. Materials

50mm thick extruded polystyrene rigid insulation board of required size for Underdeck Insulation System, complying with ISO 4898:2008 & ASTM C 578-08b-type VI, having thermal conductivity of 0.0289 W/mk as per ASTM C 578 (Measured as per IS 3346), Compressive strength of 350 KPA listed as per ASTM D 1621, density of 34-36 kg/Cum as per ASTM D 1622, Water absorption ≤ 1% by Volume as per ASTM D 2842, Oxygen Index of 24.1 to 28.1 listed as per ASTM D 2863, cell size 0.4mm of dia (max) as per ASTM D 3576. Fire retardant property as per DIN, Part 1 of Class B2 and as per ASTM E 84 Class A.

b. Installation Process

i. The specified Under Deck Insulation System shall be applied by an Authorized applicator only.

ii. The level of the slab should be checked and kept within permissible limit of variation of 3 to 5mm.

iii. The Substrate/ Roof Underdeck on which the insulation system needs to be installed must be free from all waste products such as petroleum, grease, oil, solvents, vegetable or mineral oil, animal fat etc.

iv. The Insulation board must be fixed to the concrete slab from inside with the help of water based adhesive and Fasteners with PVC Capping. This has to be ensured that the PVC screws are embedded in the concrete with a minimum distance of 50mm from the edges and have a pull out strength of 0.3 kN.

c. Requirement for extruded polystyrene rigid insulation board

Since this product is a performance based product, the third Party testing is Mandatory and should be done from any NABL approved laboratory or any other accreditation body which operates in accordance with test ISO/IEC 17011 and accredits labs as per ISO/IEC-17025 for testing. The pattern of laying XPS and location of fasteners shall be as directed by the Engineer-in-Charge.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Requirement</th>
<th>Test Standard</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Thermal Conductivity Having 180 days aged thermal conductivity of 0.0289 W/mk.</td>
<td>ASTM C 578</td>
<td>Mandatory</td>
</tr>
<tr>
<td>2</td>
<td>Compressive strength of &gt; 350 KPA.</td>
<td>ASTM D 1621</td>
<td>Mandatory</td>
</tr>
<tr>
<td>3</td>
<td>Density of 34-36 kg/Cum.</td>
<td>ASTM D 1622</td>
<td>Mandatory</td>
</tr>
<tr>
<td>4</td>
<td>Water absorption &lt; 1% by Volume.</td>
<td>ASTM D 2842</td>
<td>Mandatory</td>
</tr>
<tr>
<td>5</td>
<td>Oxygen Index of 24.1 to 28.1</td>
<td>ASTM D 2863</td>
<td>Mandatory</td>
</tr>
<tr>
<td>6</td>
<td>Cell size 0.4mm of dia (max).</td>
<td>ASTM D 3576</td>
<td>Mandatory</td>
</tr>
<tr>
<td>7</td>
<td>Fire retardant property as per DIN, Part 1 of Class B2</td>
<td>-----</td>
<td>Mandatory</td>
</tr>
<tr>
<td>8</td>
<td>Fire retardant property</td>
<td>ASTM E 84 CLASS A</td>
<td>Mandatory</td>
</tr>
</tbody>
</table>
13 WATER PROOFING

13.1 Water Proofing Treatment-General:

i. All the items for water proofing treatment with cement based water proofing treatment for roof slab and sunken portion shall be guaranteed for TEN YEARS, to be reckoned from the date of expiring of the Defect Liability period prescribed in the contract. The Guarantee shall be furnished by the contractor as per Performa prescribed.

ii. The treatment for water-proofing of basement, roofs, water retaining areas hall be of type and specifications as given in the tender drawings/ DBR and remain fully effective for a period of not less than 10 (Ten) years to be reckoned from the date of expiring of the Defect Liability period, prescribed in the contract. At any time during the said guarantee period if the CLIENT/HITES or his representative finds any defects in the said treatment or any evidence of re-infestation, dampness, leakage in any part of buildings or structure and notifies the contractor of the same, the contractor shall be liable to rectify the defect or give re-treatment and shall commence the work or such rectification or re-treatment within seven days from the date of issue of such letter to him. If the contractor fails to commence such work within the stipulated period, the CLIENT/ HITES or his representative may get the same done by another agency at the Contractor’s cost and risk and the decision of the CLIENT/ HITES for the cost payable by the contractor shall be final and binding upon him. Re-treatment if required shall be attended to and carried out by the Contractor within seven days of the notice from the CLIENT/ HITES or his representative.

iii. The work shall be got executed from the specialized agency as approved by the Engineer-in-Charge.

iv. Total quantity of the water proofing compound required shall be arranged only after obtaining the prior approval of the make by Engineer-in-charge in writing. Materials shall be kept under double lock and key and proper account of the water proofing compound used in the work shall be maintained. It shall be ensured that the consumption of the compound is as per specified requirements.

v. The finished surface after water proofing treatment shall have adequate smooth slope as per the direction of the Engineer-in-charge.

vi. Before commencement of treatment on any surface, it shall be ensured that the outlet drain pipes / spouts have been fixed and the spout openings have been eased and rounded off properly for easy flow of water.

vii. The approved specialized agency for the work of water proofing will have to execute a guarantee bond in prescribed Proforma enclosed at ANNEXURE-II for removing any defects for at least 10 years. Guarantee bond shall be signed by both the specialized agency as approved by the Engineer-in-Charge and the Contractor to meet their liability under the guarantee bond. However, the sole responsibility about the efficiency of water proofing treatment shall rest with the Contractor.

viii. 10% of the assessed value/ cost of water proofing work as finalized by Engineer-In-Charge shall be retained as additional security deposit and the amount so withheld would be released after ten years from the date of issue of Final completion Certificate of the entire work under the agreement. If the performance of the work done is found unsatisfactory and any defects noticed during the guarantee period, they shall be rectified by the Contractor within seven days of receipt of intimation of defects in the work. If the defects pointed out are not attended to within the specified period, the same will be got done from another agency at the risk and cost of the Contractor.

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

13.2.1 Horizontal Surface (Raft Slab)

i. Before the raft reinforcement is placed in position:
13.2.2 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 upto 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.

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 I.S.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

13.4.1 Integral Crystalline Waterproofing Admixture

i. Materials

Integral Crystalline Admix is one part cementitious 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 fulfil 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 40°F (4°C).

viii. Storage / Shelf life

Integral crystalline admixture must be stored dry at a minimum temperature of 45°F (7°C) and its shelf life is one year when stored under proper conditions.

13.4.2 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 fulfil 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 prewatered 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>5 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 @0.70kg 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.
13.4.3 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 fulfil 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 45°F (7ºC) and its shelf life is one year when stored under proper conditions.

**13.4.4 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 fulfil 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, trowelable 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 upto 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 upto 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 40°F (4°C), 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 45°F (7°C). Shelf life when stored in proper conditions in unopened, undamaged packaging is 12 months.

14 ROOFING

14.1 Polycarbonate Sheet Roofing

a. The polycarbonate sheet roofing shall be of approved make and shall conform to manufacture’s specifications. The material procured shall be free of any defects and damage to the edges, surface etc. The contractor shall ensure that the material is procured and delivered at installation site without any damage.
b. Adequate care shall be taken for protection of the material before installation as well as afterwards till handing over the building for occupation. The contractor shall ensure careful handling and storage and prevent any rough handling, to prevent any edge or surface damage. Any panel with edge damaged or damage to the finish etc. shall not be allowed to be used in the work and shall be replaced by the contractor at his own cost. The contractor shall procure the material including providing for wastages, damages etc. in one lot so as not have any color and shade variation. Atleast one sample of the polycarbonate sheets brought by the contractor to the site of work shall be tested. The test shall be got done at reputed independent laboratory as approved by the Engineer-in-Charge. However, the contractor shall obtain and submit to the Department the manufacturer’s certificate for compliance of the polycarbonate sheets as per the manufacturer’s specifications and also copy of the manufacturer’s test report for the record.

c. The polycarbonate sheet shall be multi-wall (twin wall) section with thickness of the sheet not less than 16mm and the thickness of the walls on the two external faces not less than 0.8mm each. The sheet shall be extruded from polycarbonate material and shall have homogeneous composition of the material. The sheet shall have co-extruded UV protective layer. The sheet shall be fixed with the face treated for UV resistance, upward/exposed to sunlight. The weight of the sheets shall not be less than 2.7 Kg per sq.m. Light transmission shall be minimum 35% or as per manufacturers specifications. The sheets shall be obtained with closed edges. The sheet shall be bent (if required) to the require profile as per the architectural drawings but with radius not less than 175 times the thickness of the sheet. The sheet shall be fixed in a manner that the cells are parallel to the span of the shed.

d. The polycarbonate sheets shall be of colour and shade as approved by the Engineer-in-Charge.

e. The physical and the chemical characteristics of the polycarbonate sheets shall be as per the manufacturer’s specifications and shall conform to the ASTM standards. The sheets shall conform to BS 476 part 7 for the fire rating. The contractor shall submit written guarantee to the Engineer-in-Charge for the polycarbonate sheets procured and provided by him against any defects like peeling, breakage, fading of color/discoloration, cracking, leakage through the roofing loss of strength etc. for a period of ten years after the date of completion of the work. The contractor shall obtain similar back-to-back guarantee from the manufacturer.

f. The polycarbonate sheets shall be used in one piece along the span of the temporary sheds. The width of the sheet across the span of the shed shall not be more than 700 mm. The polycarbonate sheets shall be bent to required profile (linear or curvilinear) as per the architectural drawings and fixed in position, to the structural steel framework, using self-driving self-tapping screws with EPDM washers etc. The sheets shall be secured to the structural steel framework so as to withstand all the design dead, live, wind, other accidental loads etc. and shall be fixed in a workmanlike manner. It shall not have any sag. Therefore the fabrication work shall be got done through experienced & reputed fabricator, to be got approved from the Engineer-in-Charge. The contractor shall submit to the Engineer-in-Charge the shop drawings giving fixing details for the polycarbonate sheets in roofing and also quality assurance and methodology statement for the item. The polycarbonate sheets shall be jointed along the length of the shed using aluminum top & bottom pressure plates having required profiles for fixing the EPDM gaskets, screws, washers etc. The aluminum pressure plates shall be color anodized or powder coated to the require shade. The joints in the sheet shall be provided only on the RHS steel sections of the framework and shall not be permitted elsewhere. The joint width of about 3-4 mm may be provided between the sheets at the junction for thermal expansion. The EPDM gaskets of the required profiles shall than be fixed in the grooves in the aluminum pressure plates on either side of the joint in the polycarbonate sheet. The bottom aluminum plate shall be fixed to the structural steel framework using self-driving self-tapping screws; washers etc. (one screw fixed to each sheet) and the screws fixed @300 mm center to center along the span of the shed.
g. The EPDM gaskets of the required profile shall be fixed in the grooves in the aluminum pressure plate on either side of the joint in the polycarbonate sheet. The top aluminum pressure plate shall than be fixed securely to the bottom aluminum plate using countersunk self-driving self-tapping screws, EPDM washers etc. All the screws shall be concealed using structural silicone sealant DC 995 of Dow Corning or equivalent approved brand. Also, wherever required (especially at the joint in the EPDM gasket etc.) the junction of the polycarbonate sheet and the sides of the pressure plates on both sides shall be sealed using structural silicone sealant DC 995 of Dow Corning or equivalent brand as approved. The item includes cost of all the operations and all inputs of the materials including Polycarbonate sheet, EPDM gaskets, anodized aluminum capping, anodized aluminum edge capping to the sheet with U-shaped EPDM gasket, all structure silicone sealant, self-driving self-tapping screws with EPDM washers, nuts, bolts, washers etc. and the like, labor, T & P, all the incidental charges, wastages etc. involved in the work. The contractor shall maintain the roofing scratch and damage free till the handling over the building for occupation, at his own cost. Tolerance shall be as per manufacturers specifications.

h. The polycarbonate sheets shall be obtained with protective films on both sides. Care shall be taken while fixing to fix the sheets with UV protected side exposed to outside. The sheet shall be stored in a manner not to expose to direct sunlight. The sheet shall be cut to the required size or drilled using the toothed blade/machine. After fixing the protective film shall be removed and the sheets cleaned using non-alkaline based detergent and abrasive equipments or solvents be avoided. The silicones, gaskets, tapes etc. shall be compatible with the polycarbonate sheet.

i. For joining the sheets, at least one complete channel width of each sheet shall be secured per sheet within the joining profile. Since thermal coefficient of expansion of the sheets is different from the RHS steel frames, suitable provision shall be made for accommodating differential expansions. Also any rigid jointing agent that may prevent thermal movements shall not be used. The required section aluminum profiles (upper central profile, lower central profile and top profile) for fixing the polycarbonate sheet to the structural framework as well as for joining the sheet shall be as per the manufacturer’s specifications. The top capping profile shall be snap fit to the upper central profile, The EPDM gaskets and the screws shall be provided as per the manufacturer’s specifications.

j. The Gaskets shall be extruded micro wave/steam cured EPDM/ silicone of approved quality compatible with substrates, finishes and other components they are in contact with. All gaskets exposed directly on the exterior face shall be silicon gaskets, which are UV resistant. They shall not degenerate/discoor or/each on exposure to weather/rain/pollutants etc.

14.2 **Puff Insulated Roofing** :-

Approved make Puff Insulated roofing sheet 40 mm thick with 38 mm High Rib, Double skin sandwiched between Pre painted Gallvalume (PPGL) sheet having outer skin 0.47mm thick Pre-coated GL Sky Blue or as approved colour Sheet with depth of crest-30-40mm, pitch 195-200mm trapezoidal colour coated sheet & inner skin 0.47 mm thick Pre-coated GL White Sheet & minimum 40+30 mm thick layer of rigid CFC free polyurethane foam of density of 40±2 kg/m3 as insulation and PPGI sheet shall have minimum coating of 4-5 micron epoxy primer and 25 micron polyester top coat on the finish surface and 7-8 micron primer alkyl base on reverse complete with Skirt Flashing, Corner Flashing and Rain Gutter 1.6 mm Thick G.I. Sheet.
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 required 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 with in 260mm of leading or trailing edge, or 0.076 mm 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 PANELLING

16.1 Wooden Panelling

Providing and Fixing Channeled Wooden perforated panels of width 128mm, thickness of 6mm and length 2440 mm or as required by the Engineer-In-Charge, made of a high density particle board substrate with a laminated facing as per the approved shade/species & finish and a melamine balancing layer on the reverse side. The boards shall have a special perforation pattern where the visible surface has a (“Helmholtz” fluted perforation of 2mm width and 14mm of visible panel / 4mm width and 28mm visible panel) each. The panels shall provide a minimum sag resistance of RH90 and a fire rating class of 1 as per Part 7 of BS 476. The edges of the panels shall be “tongue-and-grooved” to receive special clips for installation. The back of the perforated panel shall have sound absorbing non-woven acoustical fleece. The panels shall be mounted on special aluminium splines using clips approved by the Engineer-in-Charge.

16.1.1 Installation:

Install wooden battens (provided by others) of section 50mmx50mm or as approved by the HITES on the solid wall horizontally using screws and plugs at spacing of 600mm centre-to-centre. Screw the aluminium extruded keel for channelled wood(GTPT001) over the lowest and second wooden batten at an on-center distance of 600mm. Install the first set of wooden panels by inserting the clips for border channelled wood(GTPT002) and insert the groove of the panel into the projecting flange of the aluminium clip. Continue installing rows of panels by inserting the tongue into the groove
of the earlier inserted panel and progressively installing clips for inside channelled wood (GTPT003) into the next keel till the actual height is achieved. Use clips for border channelled wood (GTPT002) to finish off the installation. Finish off the edges using wooden moulding of matching colour.

16.2  
ACOUSTICAL WALL PANELLING

16.2.1  Providing and supplying Acoustical Wall Panelling of Slats made of pinewood E1 grade fibreboard, Melamine laminated finish, groove perforated slats L16-2 - (2mm Slats @16mm pitch) / L32-2 - (2mm grooves @ 32mm centers) / L64-2 - (2mm grooves @ 64mm centers), backlined with black acoustical fleece, tongue-groove edge for a seamless look, of size 75/150x2440mm with min 15mm thick having base density 800Kg/m³, weight 12Kgs/m² installed by using GI strut system. The GI strut system includes two layers of GI Cross channel (CC50) having thickness 0.45mm, length 3600mm, knurled web 40mm, depth 50mm and equal flanges 15mm is fastened vertically/horizontally at every 600mm centers. Aluminium core cross channel (CC18) having thickness 0.5mm, length 2400mm, web 15mm & 27mm, depth 18mm and flanges of 7mm with suitable edge & centre brackets is then fixed perpendicular to the CC50 with the help of fasteners at every 400mm centers. Slats of size 75/150x2430mmx16mm in then fixed perpendicular to CC18 with suitable edge & centre brackets. Contractor to provide expansion joints of 3mm at every 5mtrs bothways. Panels shall be backlined with acoustical infill of Synth PF 5x50mm thick adhered to the wall using Stick 7 adhesive.

Technical Parameters
• Core Variants - Pinewood E1 Fibreboard
• Fire – Class 1 & P
• Acoustics – NRC upto 0.75
• Climate (OC RH) – 50, 70
• Light reflectance – 75% (beech haya)
• Green (RC %) – 25
• Hygiene (VoC, Clean room) – Low, Class 1
• Strength, Load capacity (Kg) - Ball-Impact

16.2.2  Providing and supplying Acoustical Wall Panelling of Hush burled square edge, FR grade fabric (colour choice) wrapped glassfibre core panel of size 600x1200x25mm having density 100-120Kgs/m³, weight 3.0kg/m² installed by using impaling clip Impaling clips are attached directly to the wall/frame work with the points extending outward. The spikes are tipped with Stick S7 adhesive. Then the panels are positioned and pressed into place

Technical Parameters
• Core - Glassfibre
• Fire – Class 1 & P
• Acoustics – NRC up to 0.9
• Climate (OC RH) – 40, 90
• Termite resistance – Yes
• Light reflectance – Colour dependent
• Green (RC %) – 25
• Hygiene (VoC, Clean room) – Low, Class 3

16.2.3  Providing and supplying Acoustical Wall Panelling with square edges made of fibre glass substrate 25mm thick and wrapped on the front side with an acoustically
transparent and fire-resistant fabric with an option of colours as per the choice of the Engineer-in-charge of size 2100x600 or 600x600 mm providing a minimum sound absorption level of 0.90 NRC to be affixed to wall using Wall panel impellers and construction adhesives as per the instructions laid down by the manufacturer.

16.2.4 Installation:

Wall panel impellers of adequate quantity as specified by the manufacturer shall be fixed to the wall surface using self-tapping screws. Silica based construction adhesive shall be dabbed on to the projecting elements (spikes) of the impellers. Wall panels shall be pierced through the spikes of the impellers ensuring the line and level of the panels are maintained.

17 SEISMIC / MECHANICAL EXPANSION JOINTS

a. The treatment of Seismic / mechanical expansion joints shall be carried out strictly as per the specifications mentioned herein. In the absence of specifications of any material, relevant I.S. specifications shall be followed and in case any material is not covered up in the specifications; Engineer-in-charge’s instructions shall be followed. No deviation shall be permissible unless specifically approved by the Engineer-in-charge.

b. The work shall be carried out as per CPWD specifications and directions of Engineer-in-charge.

c. The work shall be carried out as per site requirement. The contractor shall submit detailed drawing/shop drawing for each type of joint within three days from the date of award and shall be got approved from Engineer-in-charge before execution of the work.

d. The contractor shall make minor modification in the samples as per site requirement with the approval of Engineer-in-charge if required and nothing extra shall be paid for this modification.

e. The contractor shall submit the test reports of the product of the manufacturers.

f. Manufacturers:- All seismic/mechanical expansion joints shall be designed and manufactured by the approved manufacturers.

g. Guarantee:- All the joints shall be guaranteed at least for the period of 5 years when installed by the certified applicator in the prescribed performa.

h. Installation:- Installation shall be in strict accordance with manufacture’s technical specifications, details and installation instructions. The work shall be carried out through the specialized agencies as approved by the Engineer-in-charge.

i. Protection:- The system and its component should be protected during construction and after work is complete, the exposed surface and adjacent areas should be cleaned by suitable cleaner to the satisfaction of Engineer-in-charge.

j. Sample for joints:- The agency shall supply sample of minimum one meter length of all types of expansion joints and the same shall be fixed at site at appropriate location and the same shall be approved by the competent authority which shall be duly intimated by Engineer-in-Charge. The agency shall place the order for procurement of mechanical expansion joint from the parent company for supply only after obtaining approval from Engineer-in-Charge.

k. Materials:-

a. EPDM (Ethylene Propylene Dinine membrane) water resistant membrane shall be as per manufacturers specifications and shall be of best quality. The EPDM membrane shall be pasted with approved adhesive to the surface.

b. S.S. screw shall be of canon or equivalent make approved by Engineer-in-charge.

c. Aluminum sheet shall be of approved make and shall generally confirm to IS: 737-1986. The powder coating on aluminum sheet shall be 50-60 microns.
slots on the aluminum sheet shall be made by lath machine with smooth and uniform finish.

l. For any discrepancy in item and corresponding drawing, the decision of Engineer-in-Charge shall be final and nothing extra shall be paid on that account.

18 BUMPER GUARD STRETCHER GUARD CRASH RAIL SYSTEM & WALL GUARD

18.1 Bumper Guard Stretcher Guard Crash Rail System

i. The scope of work includes providing & fixing Bumper Guard / Stretcher Guard Crash Rail System of approved make consisting of continuous aluminum retainer, impact absorbing strip (B-ABS), adjustable end cap / corner joint, adjustable adaptor plate and high impact vinyl acrylic cover of desired shade to withstand impact and providing a cushioned surface with its integrated rubberized absorber complete as per manufacturer's specifications.

ii. The Bumper Guard / Stretcher Guard Crash Rail System shall be able to protect walls that are susceptible to trolley traffic, preventing unsightly scuffs and costly damage.

iii. This system shall be so designed to withstand impact and provides a cushioned surface with its integrated rubberized absorber, making it ideal for areas like high traffic corridors, loading bays and light cargo lifts.

iv. Bumper Guard shall be manufactured from specially developed vinyl acrylic materials and has the following qualities:
   a. Able to withstand high impact and abrasion
   b. Weather resistant and fire retardant
   c. Textured to provide an anti-slip surface

v. Fittings and anchorages that can withstand corrosion when exposed to normal environmental conditions

vi. Easy to install and maintain

vii. Tested to UL-94 (Underwriter's Laboratory) with a V-0 rating for fire retardance

viii. Designed and comply with static load, impact and deflection requirement in accordance with applicable applications in ASTM-E894 and ASTM-E935.

ix. It should consist of the following:

   • Continuous Aluminum Retainer
   • Impact Absorbing Strip (B-ABS)
   • Adjustable End Cap / Corner Joint
   • Adjustable Adaptor Plate
   • High Impact Vinyl Acrylic Cover as per approved colour and shade.

18.2 Wall Guard Grab Rail /Hand Rail System

i. The scope of work includes providing & fixing Wall Guard Grab Rail /Hand Rail System of approved make consisting of Continuous aluminum retainer, adjustable Rail mounting base (HRAM) adaptable to uneven wall surface, impact absorbing strip (B-ABS), end cap, corner joint, high impact vinyl acrylic snap- on cover desired shade to withstand impact and providing a cushioned surface with its integrated rubberized absorber complete as per manufacturer's specifications.

ii. The Wall Guard Grab Rail/Hand Rail System shall be developed to assist building users when ambulating along corridors and ascending or descending stairs. It is also suitable for helping physically handicapped persons to move within a building.

iii. Handrail System is applicable in the following circumstances:-
a. Ramp- Rail System – along the sides of a ramp
b. Stair- Rail System- along the sides of a stairway and landing
c. Transfer- Rail System- to support and allow transfer of body weight in locations such as toilets, shower and bathtub enclosures.

d. Transfer Rail System - to support and allow transfer of body weight in locations such as toilets, shower and bathtub enclosures.

iv. The Wall Guard Grab Rail/Hand Rail System shall be made from a special, high impact vinyl acrylic material, the Handrail System has the following qualities:
   a. Able to withstand abrasion
   b. Weather resistant and fire retardant
   c. Textured to provide an anti-slip surface
   d. Fitting and anchorages that can withstand corrosion when exposed to normal environment conditions
   e. Tested to UL-94 (Underwriter's Laboratory) with a V-0 rating for fire retardance

v. The Wall Guard Grab Rail/Hand Rail System shall be designed and shall comply with static load, impact and deflection requirement in accordance with applicable applications in ASTM-E894 and ASTM-E935.
   a. Continuous Aluminum Retainer
   b. Adjustable Rail Mounting Base (HRAM)- adaptable to uneven wall surface
   c. Impact Absorbing Strip (B-ABS)
   d. End Cap
   e. Corner Joint
   f. High Impact Vinyl Acrylic Snap- On Cover as per approved colour and shade

19 ROADS, PATHWAYS

The campus roads are to be constructed with filling of earth, preparation of sub-grade, two layers sub-base WBM each of 150 mm, 80 mm thick PCC and finished with RCC 200mm thick as per IRC code with Vacuum Dewatered concrete. All the main RCC roads are to be constructed as per road section drawings and as per IRC code. Following are the types of roads are proposed:

(i) Vacuum Dewatered RCC Road as shown in drawing.
(ii) For pedestrian movement and parking areas, paver blocks/ Grass-Crete blocks/Chequered CC tiles shall be used, as required.
(iii) Kerb stones: All roads edges shall be provided with kerb stones.
(iv) Adequate no. of hume pipes (RCC Pipes) of suitable dia. shall be laid across the roads/pathways etc. for crossing of cables, pipe etc. as per requirements.

Service roads from main RCC roads to all round the buildings are to be constructed, as per firefighting norms. The specifications for these roads shall be as subgrade with power roller, two base course 150mm each thick with WBM, 200 RCC M-30 concrete with nominal reinforcement (approx. 20 kg/sqm) with de-watering process with expansion/construction joint incl. filler joint shall be constructed as per CPWD specifications.

From Service roads, 3m wide footpath with 80 mm thick interlocking pavers with 100m base lean concrete 1:4:8 (20% coloured pavers) upto building entrance to be constructed as per CPWD specifications.

All ramps for handicapped/disabled persons are to be provided as per norms for all buildings.

Foothpaths with above specifications are also to be provided for all SS points of the buildings.
Painting and marking of the roads, parking, cycle tracks footpaths and handicapped ramps are to be completed as per standard road signs & specifications.

a) Parking
   (i) Provision for parking spaces has been made on the basis of “Equivalent car space” (ECS) as laid down under “Building Bye Laws” of Guwahati Development Authority.
   (ii) Parking space has been planned with adequate vehicular access to a street and the area of drives, aisles and such other provisions required for adequate manoeuvring of vehicles shall be exclusive of the parking space.

b) Grass Pavers
   The grass pavers shall be of size 300mm x 300mm and thickness of 70 mm should be prefab factory made cement concrete interlocking grass pavers of M-30 mix, suitably reinforced and manufactured in jointless moulds on vibrator table finished smooth as per required shape size and pattern and colour. To be laid over 50mm thk. sandbed on top of consolidated earth after proper levelling and dressing of ground surface to the requisite slopes complete in all respects as per directions and instructions of Engineer in charge.

c) Interlocking Pavers
   The Interlocking pavers shall be of required size and thickness 80 mm factory made cement concrete interlocking pavers in cement concrete of mix M-30 manufactured in jointless moulds on vibrator table finished smooth as per required shape size and pattern and colour. To be laid over 50mm thk. sandbed on top of consolidated earth after proper levelling and dressing of ground surface to the requisite slopes complete in all respects as per CPWD Specifications & directions and instructions of Engineer in charge.

20 AUDITORIUM CEILING SPECIFICATIONS

Acoustical infill Ceiling Tiles of 595x1195x20/25mm, Square edge of approved make, The Ceiling Tiles to be magnesite-bonded pine wood fibre core pigmented with volume density 400Kgs/m3, weight 8/10kg/m2 and shall be suspended by using 0.3mm thick metal grid system as per manufacturer specification all complete as directed by Engineer-in-charge.

Technical Parameters

- Fire (Class) – 1 & P
  - Acoustics – NRC 0.87 (For 15mm thk C50 Mounting)
  - Thermal conductivity (W/mk) – 0.08
  - Climate (°C, RH) – 50, 90
  - Light reflectance (%) – Low light reflectivity
  - Green (VoC, RC %) – Low, 30

21 AUDITORIUM FURNITURE

(i) Auditorium Chairs:

1. Understructure:
   MS black powder coated understructure with integrated, auto tip-up mechanism. Footprint area of base plate shall be 150mm X 230mm X 5mm thick. Backrest supporting beam width: 460mm (L) X 80 X 40 – 14 BG HR tube. Understructure should be fixed to ground by foundation expansion bolts M10 X 100 with washer and nut.

2. Seat Assembly:
Seat assembly is made of Polyurethane foam moulded with 1.5 cm. thick plywood insert as per the following dimensions:

* Approx. Seat size: Depth: 420.0 mm (D). Width @ rear: 440.0 mm. Width @ front: 410.0 mm.

Effective seat width (W): 460.0 MM. Effective seat depth (D): 450.0 MM.

3. Backrest Assembly:

Back assembly consists of Polyurethane foam moulded with MS tubular frame insert. The insert is composed of Diameter 19mm x 168G MS tubular frame with flexible nylon support straps running across the length and width of the frame. * Approx. Back size: Height: 540.0 mm (H). Width @ top: 340.0 mm. Width @ seat level: 460.0 mm.

4. Polyurethane Foam:

The polyurethane foam used for seat and back is moulded with density = 45± 2 kg/c.m.5.

5. Upholstery:

Stitched fabric upholstery as per following specs.

<table>
<thead>
<tr>
<th>Velvet finish</th>
<th>Std fabric (Glory shades)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wt.:</td>
<td>370 gm/running meter</td>
</tr>
<tr>
<td></td>
<td>320 gm/running meter</td>
</tr>
<tr>
<td>Fabric width</td>
<td>1.35 M</td>
</tr>
<tr>
<td></td>
<td>1.2 M</td>
</tr>
<tr>
<td>Specs:</td>
<td>100% Polyester</td>
</tr>
<tr>
<td></td>
<td>100% Polyester</td>
</tr>
</tbody>
</table>

6. Back Cover and Mech. Cover:

ABS Vacuum formed back & Mech. cover are provided.

7. Armrest Assembly (For Plastic Armrest):

It is a plastic injection moulded piece with upholstered arm pad made up of 8mm thk. MDF board with 6mm U-foam over it & fabric. Armrest is covered from side with upholstered pad of 8 mm thk. MDF with 6mm U-foam & fabric.

8. Desklet Assembly (For Plastic Armrest):

The invisible plastic quarter desklet assembly is housed within the armrest. It consists of spring loaded retractable mechanism & plastic desklet made of H.I.P.S. Material.

(ii) Meeting Room/Conference Hall Chairs

1. Seat/Back Assembly: The seat should be made up of 1.2 ±0.1cm thick hot pressed plywood and upholstered with fabric or synthetic leather and moulded Polyurethane Foam. The back should be made up 1.2 ±0.1cm. thick hot pressed plywood upholstered with replaceable fabric or synthetic leather upholstery covers and moulded polyurethane foam. The back ply and foam should be designed with contoured lumber support for comfortable seating posture. BACK SIZE 48cm.(W) X 64.5cm.(H) SEAT SIZE 51.0cm.(W) X 48.0cm.(D)

2. High Resilience (Hr) Polyurethane Foam: The HR polyurethane foam for seat and back should be moulded with density = 45 +/-2 kg/m³ and Hardness load 16 ± 2 kgf for 25% compression.

3. Armrests: The armrest top should be made of moulded polyurethane (P.U) and mounted on to a fixed type M.S. tubular armrest support chrome plated. The arm support has static vertical adjustment of ±1.5±0.05cm.

4. Front Pivot Synchro mechanism:

The mechanism should be designed with the following features:

* 360° revolving type.
* Single point control.
• Front pivot for tilt with feet resting on ground ensuring more comfort.
• Tilt tension adjustment.
• 4-position locking with anti-shock feature.
• Seat back tilting ratio of 1:2.

5. Fixed Backrest
The backrest should be of a fixed type mechanism i.e. no back up/down adjustment.

6. Pneumatic Height Adjustment
The pneumatic height adjustment has an adjustment of 9.0 ± 0.3cm.

7. Pedestal Assembly:
The pedestal should be fabricated from 0.2 ± 0.02 cm thick HR sheet (should be : DD 1079 / HR skin pass), chrome plated and assembled with injection moulded black polypropylene hub cap and 5 nos. twin wheel castors. The pedestal should be 66.0 ± 0.5cm. Pitch-center dia. (76.0 ± 1.0cm. with castors).

8. Twin Wheel Castors:
The twin wheel castors should be injection moulded in black Nylon.

22 WARDROBE:
Wardrobes to be 2100mm in height and 600mm deep and specified length and or as per tender drawings/ finishing schedule/ scale of amenities mentioned in the DBR, Vol-4 complete in all respect with fixing hanger rod etc. The wardrobe shall be made of approved 19mm thick laminated Board(back, sides, base and top) with shelves and shutter. Laminated 25mm thk Shutter provided with Stainless Steel locks and Handle & other fixtures (as per approved sample). Board/ fixtures/ Hinges etc. shall be as per approved make. Lipping etc. required shall be carried out with 2nd class Teakwood. The painting/ polishing shall be carried out as per requirement.

23 DRY STONE PITCHING
Stones: These shall be clean, hard stones, free from decay and weathering. They shall be in block and hammer dressed on all sides. The size of the pitching stones shall be approximately 22.5 cm in depth and not less than 15 cm. in any other direction.

Preparation of surface: The sides and bottom of earth work to be pitched, shall be brought to the required slope and gradient and shall be compacted to a firm and even surface.

Pitching: Pitching shall be of 22.5 depth unless specified otherwise. Profiles shall be put up by means of pegs and strings or by placing stones, at intervals of not more than 15 cm. Stones shall then be laid closely in position in between the profile and firmly embedded with joints staggered and with exposed faces true to line, gradient and in uniform slope throughout.

Cross bands of approximately 22.5 cm. width through bond stones equal to the full depth of pitching shall be provided at an interval of approximately 3 metres centre to centre both longitudinally and transversely.

The interstices between adjacent stones shall be filled in with stones of proper size, well driven in with crow bars to ensure tight packing and complete filling of all interstices. Such filling shall be carried on simultaneously with the placing in position of the large stones and shall in no case be permitted to fall behind. Final wedging shall be done with the largest sized chip practicable, each chip being well driven home with a hammer so that no chip is possible of being picked up or removed by hand.

24 G.I. BARBED WIRE FENCING WITH ANGLE IRON POSTS
Materials: G.I. Barbed wire shall be as per IS 278 and angle iron shall be as per CPWD Specification Vol. The angle shall be of size 40 × 40 × 6 mm or as specified in the tender drawings.

Spacing of Posts and Struts: The spacing of posts shall be 3.00 m centre to centre, unless otherwise specified or as directed by the Engineer-in-Charge to suit the dimensions of the
area to be fenced. Every 15th, last but one end posts and corner post shall be strutted on both sides and end post on one side only.

Fixing of Posts and Struts Pits 45 x 45 cm and 75 cm deep or as directed shall first be excavated true to line and level to receive the posts. In the case of struts, pits 70 x 45 x 75 cm deep or as directed shall be excavated to suit the inclination of the strut so that it is surrounded by concrete by not less than 15 cm at any point.

The pits shall be filled with a layer of 15 cm thick cement concrete 1:2:4 (1 cement: 2 fine sand: 4 graded stone aggregate 20 nominal size). The posts and struts shall then be placed in the pits, the posts projecting as per specified height above ground, true to line and position. The cement concrete 1:2:4 shall be filled in upto 15 cm for posts and 25 cm for struts below ground level at the base of the concrete so that the posts are embedded in the cement concrete block of size 45 x 45 x 60 cm and strut in block of size 70 x 45 x 50 cm. The concrete in foundations shall be watered for at least 7 days to ensure proper curing. The remaining portions of pits shall be filled up with excavated earth and the surplus earth disposed off as directed by the Engineer-in-Charge and site cleared.

The angle iron post at bottom shall be split and banded at right angle in opposite direction for 10 cm length to get proper grip.

Fixing G.I. Barbed Wire : The barbed wire shall be stretched and fixed in specified number of rows and two diagonals. The bottom row should be 14 cm above ground and the rest at specified spacing. The diagonal shall be stretched between adjacent posts from the top wire of one post to the bottom wire of 2nd post. The diagonal wire will be interwoven with horizontal wires by fixing the odd rows of wires first, then the diagonal cross wires and lastly even rows of wires. The barbed wire shall be held by tearing the holes of 10 mm dia in the post and tied with G.I. wire, turn buckles and straining bolts shall be used at the end post. The Barbed Wire shall be Weighing 9.38 kg /100 m (minimum).

25 SIGNAGE & ASSOCIATED WORKS

a. The scope of the work includes preparation of the Architectural Drawings/ shop drawings based on details given in the tender drawings and as directed by Engineer-in-charge. Fabrication, supply, installation and protection of the Signages shall be carried based on approved shop drawings.

b. The item of work for the respective signage shall be conforming to Specifications/ tender drawings and shall cover all operations, fabrications and their installations and materials required for finished product.

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

d. The EPC 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 and contractor is bound to follow these written instruction/ changes in design/ size etc. from Engineer-in-Charge.

e. The typical patterns shown in the drawings 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.

f. The Contractor shall 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-
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.

g. 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 nonabrasive approved cleaner for the material. Nothing extra shall be payable on this account.

h. The signages shall be fixed with stainless steel anchor fasteners or other suitable arrangement for fixing the signage.

i. The entire work shall be carried out to the satisfaction of Engineer-in-Charge.

j. The Pictures shown for Internal Signages are for reference. The shape & Size of the Signages shall be as per the reference pictures. All the Internal Signages should Bilingual (English/Hindi/Assamese). The colour of the print to be finalized after having a careful study of the Building Interior which shall be constant in all the buildings. The content of the Signages will be as per Architectural Plans.

k. The fabricator will keep a liberty to choose any one of the items between “IF, IG, IV, IX and IY”, wherever they are mentioned/marked without hanging the text height which shall be constant. For Example, if at any particular location “IG” is marked, but the content gets fitted in “IY”, the fabricator shall use “IY” in that location instead of using “IG”. Similarly, if at any particular location “IX” is marked, but the content doesn’t get fitted in “IX” with the standard font size used everywhere, but gets fitted in “IV”, the fabricator shall use “IV” in that location instead of using “IX”.

l. Way finding & Fire Exit signages suspended from Ceiling on corridors and other locations shall have content on both the two sides of the Signage for giving directions as per site requirement.

m. General Specifications of various types of Signages are given below:

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Size</th>
<th>Reference Pic</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>As per Site</td>
<td><img src="image" alt="Main Entrance Gate Signage - In English &amp; Assamese" /></td>
<td>The letters shall be of 4” depth and approximately 2'-0” to 3'-0” height as per Site requirement. The Back face &amp; the edges of the letters shall be made of 304 Grade SS and the front face of 4mm white Acrylic. One Way Vision Vinyl Printed/Painted as per approved colour and shall be pasted on top of the Acrylic Sheet. During day time, the front face of the letters will be as per Brand colour as approved by Engineer-in-Charge &amp; will turn white once lights switched on in the evening. Letters are to be illuminated with LED Modules with necessary water proof Transformers.</td>
</tr>
<tr>
<td>2</td>
<td>Approx.</td>
<td><img src="image" alt="Signage at Main Entrance Gate Boundary Wall" /></td>
<td></td>
</tr>
<tr>
<td>39'-0&quot; x 4'-3&quot; or as per final Artwork</td>
<td>Signage shall be made with 4mm ACP Sheet as per approved colour. A 5&quot;deep Box shall be made with 1.5&quot;x1.5&quot;MS Framework &amp; cladding shall be done with ACP from all sides. AIIMS Logo and Letters to be written as Bilingual. The letters shall be of 4&quot; depth and height will be as per Artwork &amp; approx. 1'-0&quot;. The Back face &amp; the edges of the letters &amp; Logo shall be made of 304 Grade SS and the front face is to be made of 4mm white Acrylic. SS Trim Cap of around 8mm shall be provided at the front face of the letters &amp; Logo. One Way Vision Vinyl Printed/Painted as per approved colour to be pasted on top of the Acrylic Sheet. During day time, the front face of the letters will be as per Brand colour as approved by Engineer-in-charge &amp; will turn white once lights switched on in the evening. The logo to remain as per Brand Colour during night also. Letters are to be illuminated with LED Modules with necessary water proof Transformers, necessary MS framework to hold the Signage firmly to the ground. The MS Members are also to be cladded with 4mm ACP with same colour &amp; specifications as the ACP used for the Signage.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Site Totems Covering Hospital & Medical College Area

**Main Totem at Entrance & inside to be Bilingual English & Hindi/Assamese as per requirement**

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Size</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 (a)</td>
<td>10'-0&quot;x 1'-6&quot;x 27'-0&quot;</td>
<td><strong>Conceptual Design</strong>&lt;br&gt;Basic structure shall be of 150mmx150mmx4mm Square Hollow Sections on both sides along with 2&quot;x2&quot; MS Framework around them to hold ACP. Grey Colour ACP Cladding around the MS Framework shall be done to make pillars of 1'-6&quot;x1'-6&quot; size. 50mmx50mmx4mm MS Angle shall be welded to the Square Hollow Sections to hold the Front &amp; Back 12mm toughened glasses as per design. Vinyl of approved colour shall be pasted from back side of the glasses. Logo, Picto &amp; content shall be made with Cut vinyl as per design which shall come only on the front facing glasses. The glasses at the back side will have only plain colour vinyl pasted from behind as per approved colour. No content to come on them. Facilities displayed in the Totems shall be finalised in consultation with end user/Engineer in charge. The top part will have glass on all four sides. The glasses to be fixed with MS Framework with SS Studs. 3 Halogens of 100 watt each shall be fixed in between the glasses for lighting of the Letters &amp; Logo. Necessary ACP work with silicon filling shall done to prevent water going inside the Glasses. Necessary RCC Foundation work shall be done for supporting the MS Sections, Base Plates, Anchor Bolts etc.</td>
</tr>
</tbody>
</table>
### Site Totems Covering Hospital & Medical College Area

Main Totem at Entrance & inside to be Bilingual English & Hindi/Assamese as per requirement

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Size</th>
<th>Reference Pic</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 (b)</td>
<td>9'-0&quot;x 10&quot;x 10'-0&quot;</td>
<td><img src="image.png" alt="Image" /></td>
<td>100mmx100mmx4mm Square Hollow Sections on both sides. 2&quot;x2&quot; MS Framework around them to hold ACP. Grey Colour ACP to be cladded around the MS Framework to make pillars of 10&quot;x10&quot; size. 50mmx50mmx4mm MS Angle to be welded to the Square Hollow Sections to hold the Front &amp; Back 12mm toughened glasses as per design. Digital print of approved colour to be pasted from back side of the glasses at the centre part for the Map and its contents. Vinyl of approved colour to be pasted from back side of the glasses for the top part. Logo, Picto &amp; content to be made with Cut vinyl as per design which shall come only on the front facing glasses. Facilities displayed in the Totems shall be finalised in consultation with end user/Engineer-in-charge. The glasses at the back side will have only plain colour vinyl/digital print pasted from behind as approved. No content to come on them. The top part will have glass on all four sides. The glasses to be fixed with MS Framework with SS Studs. LED Modules with Water proof Transformers to be fixed in between the glasses for lighting of the Map, Letters &amp; Logo. Necessary ACP work with silicon filling to be done to prevent water going inside the Glasses. Item to include necessary RCC Foundation work for the MS Sections, Base Plates, Anchor Bolts etc.</td>
</tr>
</tbody>
</table>
### Site Totems Covering Hospital & Medical College Area

Main Totem at Entrance & inside to be Bilingual English & Hindi/Assamese as per requirement

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Size</th>
<th>Reference Pic</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 (c)</td>
<td>6'-0&quot;x 9&quot; X10'-0&quot;</td>
<td><img src="image.png" alt="Reference Pic" /></td>
</tr>
</tbody>
</table>

**Conceptual Design**

- 100mmx100mmx4mm Square Hollow Sections on both sides. 1.5"x1.5" MS Framework around them to hold ACP. Grey Colour ACP to be cladded around the MS Framework to make pillars of 9"x9" size.
- 38mmx38mmx4mm MS Angle to be welded to the Square Hollow Sections to hold the Front & Back 12mm toughened glasses as per design. Vinyl of approved colour to be pasted from back side of the glasses. Logo, Picto & content to be made with Cut vinyl as per design. The glasses at the back side may also have contents if required for providing direction. Facilities displayed in the Totems shall be finalised in consultation with end user/Engineer-in-charge. The top part will have glass on all four sides. The glasses to be fixed with MS Framework with SS Studs. LED Modules with Water proof Transformers to be fixed in between the glasses for lighting of the Letters & Logo. Necessary ACP work with silicon filling to be done to prevent water going inside the Glasses. Item to include necessary RCC Foundation work for the MS Sections, Base Plates, Anchor Bolts etc.

### INTERNAL SIGNAGES—Hospital Block

**NOTE:** The Signages shown below are for reference. The shape & Size of the Signages shall be as mentioned below. All the Internal Signages should be in “BILINGUAL LANGUAGE” as per requirement. The colour of the print shall be finalised after having a careful study of the Building Interior which shall be constant in all the buildings. The content of the Signages will be as per Architectural Plans. The fabricator may keep a liberty to choose any one of the items between “IF, IG, IV, IX and IY”, wherever they are mentioned/marked without changing the text height which shall be constant. For Example, if at any particular location “IG” is marked, but the content gets fitted in “IY”, the fabricator shall use “IY” in that location instead of using “IG”. Similarly, if at any particular location “IX” is marked, but the content doesn’t get fitted in “IX” with the standard font size used everywhere, but gets fitted in “IV”, the fabricator shall use “IV” in that location instead of using “IX”. Way finding & Fire Exit Signages suspended from Ceiling on corridors shall have content on both the two sides of the Signage.
<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Size (in mm)</th>
<th>Reference Pic/Note</th>
<th>Specification</th>
</tr>
</thead>
</table>
| 1A     | 1500x2200    | Floor Wise Content to be provided covering major facilities of all the Floors | **Hospital Directory:**  
Signage to be made with 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making key holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings. |
| 1B     | 900x1500     | ![Ground Floor Directory](image) | **Floor Directory:**  
Signage to be made with 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings. |
| IC     | 550x550      | ![Mandatory Signage](image) | **Mandatory Signage-No smoking, No Mobile Uses etc:-**  
Signage to be made with 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings. |
| ID     | As per Site  | ![Reception Backdrop](image) | **Reception Backdrop:-**  
304 Grade SS Brush Finish Letters of 2.5” raising of appropriate & |
visible size to be fixed behind reception table as per interior design. AIIMS Logo and content written “AKHIL BHARATIYA AYURVIGYAN SANGSTHAN” in Local Assamese Language and “ALL INDIA INSTITUTE OF MEDICAL SCIENCES” in English.

IE 250x250

**OPD Consultant/IPD Room plate:-**
Two 3mm White Acrylic as base & top surface. 2mm white acrylic sandwiched between them. Provision of Sliding Panel with clear Polycarbonate sheet and changeable print for Doctor’s/Patient’s Name. Digital Print with Matt Lamination as per design for fixed Room No and top surface colour as approved. Provision to be made for two Doctor's name if requirement arises. Signage to be fixed by making key hole on back side or double sided tape as per site condition.

IF 900x160

**Department Nomenclature/Wayfinding:-**
Signage to be made with 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings.

IG 1800x160

**Department Nomenclature/Wayfinding:-**
Signage to be made with 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings.

IH 1800x320

**Way Finding:-**
Signage to be made with 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares.
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
</table>
| I | 900x800 | **Way Finding**:-  
Signage to be made with 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings. |
| J | 250x135 | **Door Name Plate**:-  
3mm Black Acrylic as base. 3mm Clear Acrylic as top slider. Wooden beading on both the two sides polished to match finish as per design. Note: The size of acrylic shall be 250x135 & Wooden beading to be provided additional. |
| K | 200x200 | **Change Room**:-  
Signage to be made with 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings. |
| L | 900x160 | **Fire Exit**:-  
Signage to be made with 8mm Solid bright white acrylic. Photo luminescent vinyl to be used for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings. |
<table>
<thead>
<tr>
<th>Code</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM</td>
<td>200X275</td>
<td><strong>Fire Safety in front of Lifts:</strong> Signage to be made with 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares &amp; fittings.</td>
</tr>
<tr>
<td>IN</td>
<td>200X200</td>
<td><strong>Washroom Signage:</strong> Signage to be made with 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares &amp; fittings.</td>
</tr>
<tr>
<td>IO</td>
<td>350 x350</td>
<td><strong>Level Signage:</strong> Signage to be made with 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares &amp; fittings.</td>
</tr>
<tr>
<td>IP</td>
<td>150x150</td>
<td><strong>Bed No:</strong> 6mm white Acrylic sheet as Base material. Digital print with Matt Lamination as per approved colour to be pasted on top of the Acrylic Sheet. Wall mounted signages to be fixed with 2 Mirror Screws. In case of suspended ones, they shall be suspended with Fish Wires.</td>
</tr>
<tr>
<td>IQ</td>
<td>450x450</td>
<td><strong>Pregnancy Warning:</strong> Signage to be made with 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares &amp; fittings.</td>
</tr>
</tbody>
</table>
## Pre Natal Sex Determination:
Signage to be made with 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings.

## Caution Symbol-X-Ray:
Signage to be made with 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings.

## Caution Symbol-Radiation Area:
Signage to be made with 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings.

## Caution Symbol-Restricted Area:
Signage to be made with 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares & fittings.

### 1. Facade Signages for Hospital Block

Signage shall be made of 4mm ACP Sheet as per approved colour to come up at the top of Main Entrance. A 5”deep Box shall be made with 1.5”x1.5” MS Framework to be cladded with ACP from all sides. Letters written “AKHIL BHARATIYA AYURVIGYAN SANGSTHAN” in Local Assamese Language and “ALL INDIA INSTITUTE OF MEDICAL SCIENCES” in English. The letters shall be of 4” depth and height will be as per Artwork & approx. 1’-9”.

The back face & the edges of the letters shall be made of 304 Grade SS and the front face shall be of 4mm white Acrylic. SS Trim Cap shall be of around 8mm at the front face of the letters & Logo. One Way Vision Vinyl Printed/Painted as per approved colour shall be pasted on top of the Acrylic Sheet. During day time, the front face of the letters will be as per brand colour as approved by Engineer- in charge & will turn white once lights switched on in the evening. Letters are to be illuminated with LED Modules with necessary water proof Transformers. Necessary MS framework along with base plates, anchor bolts shall has to be fabricated & erected on back side of the ACP Box to hold the Signage firmly to the terrace. (Approx. Size 59’-0”x8’-0” or as per final artwork)
2. Facade Signages for Hospital Block

Signage shall be made with 4mm ACP Sheet as per approved colour to come up at the top of the building. Placement of the signage to be decided as per visibility from the approach road. A 5" deep Box shall be made with 2"x2" MS Framework along with cladding with 4mm ACP from all sides. Letters shall be written as “AKHIL BHARATIYA AYURVIGYAN SANGSTHAN” in Local Assamese Language and “ALL INDIA INSTITUTE OF MEDICAL SCIENCES” in English. The letters shall be made of 4” depth and height will be as per Artwork & approx. 3'-3". The Back face & the edges of the letters shall be made of 304 Grade SS and the front face of 4mm white Acrylic. SS Trim Cap of around 8mm shall be provided at the front face of the letters & Logo. One Way Vision Vinyl Printed/Painted as per approved colour shall be pasted on top of the Acrylic Sheet. During day time, the front face of the letters will be as per Brand colour as approved by Engineer-in-charge & will turn white once lights switched on in the evening. Letters are to be illuminated with LED Modules with necessary waterproof Transformers. Necessary MS framework along with Base Plates, Anchor Bolts, waterproof work shall be provided on back side of the ACP Box to hold the Signage firmly to the terrace. Approx. 106'-0"x12'-0" or as per final artwork.

Facade Signages for Medical & Nursing College Block

Signage shall be of 4mm ACP Sheet as per approved colour to come up at the top of Main Entrance Canopy. A 5" deep Box shall be made with 1.5"x1.5" MS Framework to be cladded with ACP from all sides. AIIMS Logo and Letters written “AKHIL BHARATIYA AYURVIGYAN SANGSTHAN” in Local Assamese Language and “ALL INDIA INSTITUTE OF MEDICAL SCIENCES” in English shall be considered. The letters shall be made of 4” depth and height will be as per Artwork & approx. 1'-3". The Back face & the edges of the letters shall be of 304 Grade SS and the front face is of 4mm white Acrylic. SS Trim Cap of around 8mm shall be at the front face of the letters. One Way Vision Vinyl Printed/Painted as per approved colour shall be pasted on top of the Acrylic Sheet. During day time, the front face of the letters shall be as per approved colour by Engineer-in-charge & shall turn white once lights switched on in the evening. Letters are to be illuminated with LED Modules with necessary waterproof Transformers. Item to include necessary MS framework on back side of the ACP Box to hold the Signage firmly to the entrance porch. Necessary MS framework along with base plates, anchor bolts shall have to be fabricated & erected on back side of the ACP Box to hold the Signage firmly to the terrace. Approx.50'-0"x6'-0" or as per final artwork.
Letters written “CHIKITSA MAHAVIDYAALAY” in Local Assamese Language at top & “MEDICAL COLLEGE” in English at bottom shall be fixed directly on external wall. The letters shall be of 3” depth and height will be as per Artwork which shall be around 1’-9”. The Back face & the edges of the letters shall be of 304 Grade SS and the front face shall be made of 4mm white Acrylic. SS Trim Cap of around 8mm shall be at the front face of the letters. One Way Vision Vinyl Printed/Painted as per approved colour shall be pasted on top of the Acrylic Sheet. During day time, the front face of the letters will be as per approved colour by Engineer-in-charge & will turn white once lights switched on in the evening. Letters are to be illuminated with LED Modules with necessary water proof Transformers.

Signage shall be of 4mm ACP Sheet as per approved colour to be placed at the top of Administration Canopy. A 4” deep Box has to be made with 1.5”x1.5” MS Framework & to be cladded with ACP from all sides. The content “PRASHASHAN” shall be in Local Assamese Language at top & “ADMINISTRATION” in English at bottom. The letters shall be of 2.5” depth and height will be as per Artwork & approx. 7.5”. The Back face & the edges of the letters & Logo shall be of 304 Grade SS and the front face shall be of 4mm white Acrylic. SS Trim Cap of around 8mm shall has to be provided at the front face of the letters. One Way Vision Vinyl Printed/Painted as per approved colour to be pasted on top of the Acrylic Sheet. During day time, the front face of the letters shall be as per approved colour by Engineer-in-charge & will turn white once lights switched on in the evening. Letters are to be illuminated with LED Modules with necessary water proof Transformers. Item to include necessary MS framework on back side of the ACP Box to hold the Signage firmly to the entrance porch. Necessary MS framework along with base plates, anchor bolts shall has to be fabricated & erected on back side of the ACP Box to hold the Signage firmly to the terrace. Approx. 10’-0”x3’-0” or as per final artwork.
## Building Nomenclature - AUDITORIUM

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Size</th>
<th>Reference Pic with Location</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>As per Text Height</td>
<td>Same as below Pic of “Dining Hall” (below)</td>
<td>Letters to be written “PREKKHAGRIHA” in Local Assamese Language at top &amp; “AUDITORIUM” in English at bottom fixed directly on external wall. The letters shall be of 304 Grade 2mm SS and raised by 38mm. The height of the letters shall be considered as 1’-6”.</td>
</tr>
</tbody>
</table>

## Building Nomenclature - DINING HALL

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Size</th>
<th>Reference Pic with Location</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>As per Text Height</td>
<td></td>
<td>Letters to be written “BHOJANALAYA” in Local Assamese Language at top &amp; “DINING HALL” in English at bottom fixed directly on external wall. The letters shall be of 304 Grade 2mm SS and raised by 25mm. The height of the letters shall be considered as 1’-3”.</td>
</tr>
</tbody>
</table>

## Building Nomenclature - GUEST HOUSE
As per Final Artwork. Approx - 11’-0”x4’-0”

3

Signage to be made with 4mm ACP Sheet as per approved colour to come up at the top of Main Entrance Canopy. A 4”deep Box to be made with 1.5”x1.5” MS Framework to be cladded with ACP from all sides. Letters written “ATITHISALA” in Local Assamese Language and “GUEST HOUSE” in English as per artwork. The letters are to be made in 2.5” depth and height will be as per artwork and approx.12”. The Back face & the edges of the letters are to be made of 304 Grade SS and the front face is to be made of 4mm white Acrylic. SS Trim Cap of around 8mm at the front face of the letters. One Way Vision Vinyl Printed/Painted as per approved colour to be pasted on top of the Acrylic Sheet. During day time, the front face of the letters will be as per approved colour by Engineer-in-charge & will turn white once lights switched on in the evening. Letters are to be illuminated with LED Modules with necessary water proof Transformers. Including necessary MS framework on back side of the ACP Box to hold the Signage firmly to the entrance porch.

Building Nomenclature - NIGHT SHELTER

As per Final Artwork. Approx - 11’-0”x4’-0”

4

Signage to be made with 4mm ACP Sheet as per approved colour to come up at the top of Main Entrance Canopy. A 4”deep Box to be made with 1.5”x1.5” MS Framework to be cladded with ACP from all sides. Letters written “RATRI NIWAS” in Local Assamese Language at top and “NIGHT SHELTER” in English at bottom as per artwork. Specifications same as of Guest House.

Building Nomenclature - Nurse’s Hostel

Same as above Pic of “GUEST HOUSE”
| 5 | As per Text Height | Letters written “NURSE SHATRINIWAS” in Local Assamese Language & “NURSE'S HOSTEL” in English fixed directly on external wall. The letters are to be made in 304 Grade 2mm SS and raised by 38mm. The height of the letters are to be considered 1’-6”.

Building Nomenclature - PG Hostel |
|---|---|---|
| 6 | As per Text Height | Same as above Pic of “NURSE'S HOSTEL”
Letters written “PG SHATRABAAS” in Local Assamese Language & “PG HOSTEL” in English fixed directly on external wall. The letters are to be made in 304 Grade 2mm SS and raised by 38mm. The height of the letters are to be considered 1’-9”.

Building Nomenclature - UG Boy's Hostel |
| 7 | As per Text Height | Same as above Pic of “NURSE'S HOSTEL”
Letters written “UG SHATRABAAS” in Local Assamese Language & “UG BOY'S HOSTEL” in English fixed directly on external wall. The letters are to be made in 304 Grade 2mm SS and raised by 38mm. The height of the letters are to be considered 1’-9”.

Building Nomenclature - UG Girl's Hostel |
| 8 | As per Text Height | Same as above Pic of “NURSE'S HOSTEL”
Letters written “UG SHATRINIWAS” in Local Assamese Language & “UG GIRL'S HOSTEL” in English fixed directly on external wall. The letters are to be made in 304 Grade 2mm SS and raised by 38mm. The height of the letters are to be considered 1’-9”.

Building Nomenclature - LAUNDRY |
| 9 | Same as above Pic of “NURSE'S HOSTEL” | Letters written “DHOBI GHAR” in Local Assamese Language & “LAUNDRY” in English fixed directly on external wall. The letters are to be made in 304 Grade 2mm SS and raised by 38mm. The height of the letters are to be considered 1’-3”.

Building Nomenclature - AYUSH |
### Building Nomenclature - CAFETERIA

<table>
<thead>
<tr>
<th>Item</th>
<th>Details</th>
</tr>
</thead>
</table>
| 10   | As per Final Artwork. Approx-10'-0"x4'-0"
      | Same as above Pic of “GUEST HOUSE” |
| 11   | As per Text Height
      | Same as above Pic of “NURSE’S HOSTEL” |

**Signage to be made with 4mm ACP Sheet as per approved colour to come up at the top of Main Entrance Canopy. A 5” deep Box to be made with 1.5”x1.5” MS Framework to be cladded with ACP from all sides. Letters written “AYUSH” in Local Assamese Language and “AYUSH” in English. The letters are to be made in 2.5” depth and height will be as per Artwork and approx.12”. The Back face & the edges of the letters are to be made of 304 Grade SS and the front face is to be made of 4mm white Acrylic. SS Trim Cap of around 8mm at the front face of the letters & Logo. One Way Vision Vinyl Printed/Painted as per approved colour to be pasted on top of the Acrylic Sheet. During day time, the front face of the letters will be as per Brand colour approved by Engineer in charge & will turn white once lights switched on in the evening. Letters are to be illuminated with LED Modules with necessary waterproof Transformers. Item to include necessary MS framework on back side of the ACP Box to hold the Signage firmly to the entrance porch. Including necessary Base Plates, Anchor Bolts, Waterproofing etc if required.**

### INTERNAL SIGNAGES -

- Medical & Nursing College
- Ayush
- Auditorium
- Cafeteria
- Dining Hall
- Gas Manifold
- Laundry
- Bio Medical Waste
- Guest House
- Night Shelter

**NOTE:** The Signages shown below are for reference. The shape & Size of the Signages shall be as mentioned below. All the Internal Signages should be in “BILINGUAL LANGUAGE” as per requirement similar to as shown in below Pictures. The colour of the print to be finalised after having a careful study of the Building Interior which shall be constant in all the buildings. The content of the Signages will be as per Architectural Plans. The fabricator may keep a liberty to choose any one of the items between “IF,IG,IV,IX and IY”, wherever they are mentioned/marked without changing the text height which shall be constant. For Example, if at any particular location “IG” is marked, but the content gets fitted in “IY”, the fabricator shall use “IY” in that location instead of using “IG”. Similarly, if at any particular location “IX” is marked, but the content doesn’t get fitted in “IX” with the standard font size used everywhere, but gets fitted in “IV”, the fabricator shall use “IV” in that location instead of using “IX”. Wayfinding & Fire Exit signages suspended from Ceiling on corridors shall have content on both the two sides of the Signage.
<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Index</th>
<th>Item</th>
<th>Size in mm</th>
<th>Reference Pic/Note</th>
<th>Material Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IA</td>
<td>Building Directory</td>
<td>1500x2200 or as per requirement of content</td>
<td>Floor Wise Content shall be provided covering major facilities of all the Floors</td>
<td>Signage shall be of 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages shall be fixed by making Key Holes on back side whereas suspended signages shall be hanged with two SS Cylindrical Tubes with necessary hardwares &amp; fittings.</td>
</tr>
<tr>
<td>2</td>
<td>IB</td>
<td>Floor Directory</td>
<td>900x 1500</td>
<td></td>
<td>Signage shall be of 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages shall be fixed by making Key Holes on back side whereas suspended signages shall be hanged with two SS Cylindrical Tubes with necessary hardwares &amp; fittings.</td>
</tr>
<tr>
<td>3</td>
<td>IE</td>
<td>OPD Consultant/IPD Room plate</td>
<td>250x250</td>
<td></td>
<td>Two 3mm White Acrylic sheets as base &amp; top surface. 2mm white acrylic sheet shall be sandwiched between them. Sliding Panel with clear Polycarbonate sheet and changeable print for Doctor’s/Patient’s Name. Digital Print with Matt Lamination as per design for fixed Room No and top surface colour as approved shall be provided. Provision to be made for two Doctor’s name if requirement arises. Signage shall be fixed by making key hole on back side or double sided tape as per site condition.</td>
</tr>
<tr>
<td></td>
<td></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>4</td>
<td>IF</td>
<td>Department Nomenclature/ Wayfinding</td>
<td>900x160</td>
<td>Signage shall be of 8mm Solid bright white acrylic. Digital Print with Matt Lamination shall be pasted for content. Wall mounted signages shall be fixed by making Key Holes on back side whereas suspended signages shall be hanged with two SS Cylindrical Tubes with necessary hardwares &amp; fittings.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>IG</td>
<td>Department Nomenclature/ Wayfinding</td>
<td>1800x160</td>
<td>Signage shall be of 8mm Solid bright white acrylic. Digital Print with Matt Lamination shall be pasted for content. Wall mounted signages shall be fixed by making Key Holes on back side whereas suspended signages shall be hanged with two SS Cylindrical Tubes with necessary hardwares &amp; fittings.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>IJ</td>
<td>Door Name Plate</td>
<td>250x135</td>
<td>3mm Black Acrylic as base. 3mm Clear Acrylic as top slider. Wooden beading on both the two sides polished to match finish as per design. Note: The size of acrylic is 250x135. Wooden beading is additional.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>IK</td>
<td>Change Room</td>
<td>200x200</td>
<td>Signage to be made with 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares &amp; fittings.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>IL</td>
<td>Fire Exit</td>
<td>900x160</td>
<td>Signage to be made with 8mm Solid bright white acrylic. Photoluminescent vinyl to be used for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares &amp; fittings.</td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Section</td>
<td>Description</td>
<td>Size</td>
<td>Details</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>---------</td>
<td>---------------------------------</td>
<td>--------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>IM</td>
<td>Fire Safety in front of Lifts</td>
<td>200x275</td>
<td>Signage to be made with 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares &amp; fittings.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>IN</td>
<td>Washroom Signage</td>
<td>200x200</td>
<td>Signage to be made with 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares &amp; fittings.</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>IO</td>
<td>Level Signage</td>
<td>350x350</td>
<td>Signage to be made with 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares &amp; fittings.</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>IP</td>
<td>Bed No</td>
<td>150x150</td>
<td>6mm white Acrylic sheet as Base material. Digital print with Matt Lamination as per approved colour to be pasted on top of the Acrylic Sheet. Wall mounted signages to be fixed with 2 Mirror Screws. In case of suspended ones, they shall be suspended with Fish Wires.</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>IV</td>
<td>Department Nomenclature/ Wayfinding</td>
<td>750x160</td>
<td>Signage to be made with 8mm Solid bright white acrylic. Digital Print with Matt Lamination to be pasted for content. Wall mounted signages to be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares &amp; fittings.</td>
<td></td>
</tr>
<tr>
<td>Sr.No</td>
<td>Item Description</td>
<td>Size</td>
<td>Reference Pic</td>
<td>Specifications</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------------------</td>
<td>----------</td>
<td>--------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Door Name Plate</td>
<td>380X150</td>
<td><img src="image" alt="Door Name Plate" /></td>
<td>3/4” deep Wooden member polished to get colour as shown in the Picture. Two 3mm white acrylic on top of it to make a sandwich to hold the Print as per design. Acrylic size - 355x128. Acrylic to be fixed with the wooden panel with SS Screws. Provision for changing Print. The Signage to be fixed with either double sided Tape or by making key hole on back side of the wooden panel as per site condition.</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Department Nomenclature/ Wayfinding</td>
<td>600X160</td>
<td><img src="image" alt="Department Nomenclature" /></td>
<td>Signage shall be of 8mm Solid bright white acrylic. Digital Print with Matt Lamination shall be pasted for content. Wall mounted signages shall be fixed by making Key Holes on back side whereas suspended signages shall be hanged with two SS Cylindrical Tubes with necessary hardwares &amp; fittings.</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Department Nomenclature/ Wayfinding</td>
<td>1200X160</td>
<td><img src="image" alt="Department Nomenclature" /></td>
<td>Signage shall be of 8mm Solid bright white acrylic. Digital Print with Matt Lamination shall be pasted for content. Wall mounted signages shall be fixed by making Key Holes on back side whereas suspended signages are to be hanged with two SS Cylindrical Tubes with necessary hardwares &amp; fittings.</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Fire Exit/EXIT</td>
<td>380X150</td>
<td><img src="image" alt="Fire Exit/EXIT" /></td>
<td>8mm clear Acrylic with CNC engraving for content. GI sheet polished LED fitted panel on top of acrylic as shown in reference picture for lighting. Size of clear acrylic - 380x150.</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Room No plate</td>
<td>125x75</td>
<td><img src="image" alt="Room No plate" /></td>
<td>2mm 304 Grade SS brush finish panel as per reference picture. The Room no to be itched in black colour. N.B. The Room no in this signage will come only in English Language</td>
<td></td>
</tr>
</tbody>
</table>

**Main Entrance Gate Signage (Residential Zone) – English & Assamese**

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Size</th>
<th>Reference Pic</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>As per Site</td>
<td>Similar to Main Entrance Gate Signage with addition of Residential Campus in Bilingual</td>
<td>The letters shall be made in 4&quot; depth and approximately 2'-0&quot; to 3'-0&quot; height as per Site condition. The Back face &amp; the edges of the letters shall be of 304 Grade SS and the front face is to be made of 4mm white Acrylic. One Way Vision Vinyl Printed/Painted as per approved colour shall be pasted on top of the Acrylic Sheet. During day time, the front face of the letters shall be as per Brand colour as approved by Engineer – in charge &amp; will turn white once lights switched on in the evening. Letters are to be illuminated with LED.</td>
</tr>
</tbody>
</table>
Modules with necessary waterproof Transformers. ACP cladding and its necessary MS Framework shall be done if ACP work needs to be done on site to hold the letters looking at the final design of the Residential Zone Entrance Gate.

### Directional Signages for Residential Zone

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Size</th>
<th>Conceptual Design</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4'-6&quot;x 6'-0&quot;</td>
<td>[Image]</td>
<td>63mmx63mmx3mm Sq shall be provided &amp; will be Hollow SS Sections on left, right and at top. 4 connecting SS members at the centre to hold the Acrylic. 10mm Solid White Acrylic as base material at the centre. White colour Retro Reflective vinyl shall be pasted on the front &amp; back surface of the Acrylic Sheet. Blue Colour Retro Reflective Vinyl shall be pasted on top of the white vinyl for writing the contents &amp; Logo as per design. Content may come on both the two sides of the Acrylic Panel as per requirement. The edges of the Acrylic sheet shall be PU painted to match the blue colour of the Vinyl. Necessary RCC Foundation work for the SS Sections, Base Plates, Anchor Bolts etc shall be provided for anchoring the structure.</td>
</tr>
</tbody>
</table>

### Building Nomenclature Signages for Residential Zone

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Size</th>
<th>Conceptual Design</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>18&quot; Text Height.</td>
<td>[Image]</td>
<td>Letters shall be made of 304 Grade, 2mm SS to be raised by 38mm fixed on each residential unit Facade as per approved location. The text height should be 18&quot;. For a TYPE-3 house, 1st unit—the nomenclature shall come on wall is “T3-A”. Similarly for a TYPE-4 house, 3rd unit—the nomenclature to come on wall is “T4-C”. The same pattern shall be followed for other residential Blocks also.</td>
</tr>
</tbody>
</table>
26 **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 shall be kept in Sample Room under the charge of Engineer-in-Charge 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.

27 **GRIHA REQUIREMENTS:**

   Materials shall be procured by the contractor keeping in view the recycled content to conform the GRIHA requirements as detailed in SCC and elsewhere.

28 **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.

29 **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.

30 **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. These tests shall be got done from laboratories approved by Engineer-in-charge or the laboratory set up by the contractor at site as per directions of Engineer-in-charge.

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

TECHNICAL SPECIFICATIONS PLUMBING & SANITARY WORKS

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 general arrangement (GA) plumbing drawings. Tender drawings w.r.t. plumbing & sanitary works are for reference and are indicative in nature only.

2. Plumbing Fixtures

2.1. General

i. 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 for the work.

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

a. Sanitary fixtures
b. Chromium plated fittings
c. Porcelain or stainless steel sinks
d. Accessories e.g. towel rods, toilet paper holders, soap dish etc.
e. Whether specifically mentioned or not, the installation of the fixtures, appliances and accessories shall be provided with all fixing devices, nuts, bolts, screws, hangers, fasteners as required.

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

iii. All sanitary fixtures, CP Fittings and CP/SS accessories shall be as per manufacturers’ standards / CPWD Specifications.

iv. 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 in Specifications or shown on the GA drawings and will include all devices for proper fixing arrangement, nuts, bolts, screws and required connection pieces etc.

v. Wall caps shall be provided on all walls, floors, columns etc. wherever supply and disposal pipes pass through them. These wall caps shall be chromium plated brass snugly fittings and shall be large enough to cover the puncture properly and shall conform to IS: 4291.

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

vii. 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.

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

2.2. Water Closets

i. European W.C. shall be any one of the following types:
a. Wall hung wash down or
   b. single or double siphon type

ii. Each W.C. set shall be provided with an approved type of matching plastic 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.

2.3. Health faucet/spray

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 directed by the Engineer-in-charge.

2.4. Wash Basins

i. Wash basins shall wall mounted type or for under over/counter installation as specified.

ii. Each basin shall be supported on MS galvanized 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.

iii. 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.

iv. Each basin shall be provided with a single tap a hot & cold Brass CP mixer with or without pop up waste fittings, 32 mm dia. CP cast brass bottle trap with outlet pipe and Wall flange.

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

vi. Washbasins shall be fixed at proper heights as per NBC or as directed by Engineer-in-charge.

vii. 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.

2.5. Sinks

i. Sinks for kitchens, pantries, and designated utility rooms the sinks shall be stainless steel sinks with or without drain boards, as required.

ii. Each sink shall be supported by MS galvanized 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.

iii. 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.

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

2.6. Shower set

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

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

2.7. Accessories
i. Types of typical Accessories:
   a. Towel rails
   b. Towel rings
   c. Coat hooks
   d. Soap dispensers
   e. Soap dishes

ii. 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.

iii. 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.


3.1. Scope of work
i. Work 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 per requirement.

ii. Without restricting to the generality of the foregoing, the system shall include the following:
   a. Vertical and horizontal soil, waste, vent and rain water pipes, and fittings, joints, clamps and connections to fixtures.
   b. CI Hubless soil, waste & Vent pipe and uPVC rainwater pipes.
   c. Connection of all pipes to sewer lines at ground floor levels.
   d. Floor and urinal traps, cleanout plugs, inlet fittings and rainwater heads/Khurras.
   e. Testing of all pipe lines.

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

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

iii. 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.

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

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

3.3. 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 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 are to be connected to the storm water drainage system.

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

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 take pipes.

d. Hubless centrifugally cast (Span) iron pipes epoxy coated in sides and outside as per IS code 15905.& fittings (for Soil, waste, anti-siphon age pipes)

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

i. Where specified, Polythene pipes shall be uPVC pipes confirming to I.S: 4985-2000, 6kg /cm².

ii. The details of the nominal outer diameter, weight and working pressure shall be as per the standards, for the respective pressure rating.

iii. 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.

iv. 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/Ring Fit 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

i. 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.

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

iii. 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

i. 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).

ii. Horizontal pipes running along ceiling shall be fixed on structural adjustable clamps (Clevis clamps) of required shape & design 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.

iii. Contractor shall provide all sleeves, openings, hangers, inserts during the construction. All damages shall be made good to restore the surfaces.

3.4. Traps

a. Floor traps

Floor traps shall be siphon type full bore P or S type Polypropylene 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 Polypropylene 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 of P.P. pipe without, with one, two or three inlet sockets on side to connect the waste pipe. Joint between waste and hopper inlet socket shall be Ring fit / Drip Seal. Inlet shall be connected to a P.P P or S trap. Floor trap inlet fitting and the traps shall be set in cement concrete blocks.

d. Gratings for traps

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

e. Jointing

Soil, waste, vent and anti-siphonage pipes shall be jointed with Ring fit joint as per design. 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. The jointing surfaces shall be cleaned to remove any coatings etc.

f. Floor Trap Inlet/ Inlet Fitting:

Traps and connections shall ensure free and silent flow of discharging water. Where specified, Contractor shall provide a P.P. inlet fitting without or with one or two or three inlet sockets to receive the waste pipe. Joint between P.P. waste pipe and inlet socket shall be Ring fit / Solvent joint. Inlet fitting shall be connected to a P.P. ‘P’ or ‘S’ trap with at least 50mm seal. Floor trap inlet fitting and the traps shall be set in cement concrete blocks/and supports as required for Floor trap.

3.5. 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 P.P. pipe. The cleanout doors shall be of Polypropylene, gasket etc.

3.6. Waste pipe from appliances

a. Waste pipe from appliances e.g. washbasins, sinks and urinals shall be of Polypropylene pipe as shown on the drawings.

b. All pipes shall be fixed in gradient towards the outfalls of drains. Pipes inside a toilet room shall be in chase unless otherwise shown on drawings. Where required pipes may be run at ceiling level in suitable gradient and supported on galvanized structural clamps. Spacing for clamps for such pipes shall be as per good engineering practice approved by the Engineer-In-Charge.

c. Polypropylene pipes

Waste pipes from appliances shall be Polypropylene pipe conforming to EN:12056 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 P.P. waste pipes shall be terminated at the point of connection with the appliance with an outlet of suitable diameter.

3.7. Polypropylene pipes for drainage

a. All drainage lines passing under building, in exposed position above ground e.g. basement ceiling etc. shall be Polypropylene pipes.

b. Polypropylene pipes shall be conforming to EN: 12056. Quality certificates shall be furnished.

c. Fittings

Fittings used for Polypropylene drainage pipe shall conform to EN: 12056. Wherever possible, junction from branch pipes shall be made by a Y- tee.

d. Joints

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

3.8. Encasing pipe in Cement Concrete

Polypropylene 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 concrete cement pillars of required height at intervals of 1.8 m. inclusive of pillars, supports, shuttering and centring.

3.9. 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.

3.10. Testing

a. Testing procedure specified below apply to all soil, waste and vent pipes.

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 Polypropylene 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.

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

4. Water Supply Systems

4.1. Scope of work

Without restricting to the generality, 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.

4.2. 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.

4.3. 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 New Bore wells.

ii. The rising mains will be connected to the main fire static tank and then overflow into the main domestic water tanks.

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

4.4. Pipes & Fittings

In the water supply system Galvanised Iron Pipes/ CPVC Pipes/ SS Pipes / UPVC Pipes / Ductile Iron Pipes shall be provided as per approved designs.

i. CPVC pipes shall be used in the internal concealed water supply if specified in the contract. The CPVC pipes shall be conforming to I.S. 15778-2007and/or ASTM F441 Schedule 40 of Class specified and having thermal stability for hot & cold water supply and shall be heavy class. These may require to be connected to the existing/new GI pipes. The pipe and fitting approved make solvent shall be used as per approved manufacture specification.

ii. Galvanised Iron Pipes shall be used in the external water supply for upto 80mm dia and for above 80mm dia Ductile Iron Pipes shall be used, weather concealed or exposed as per approved design. These shall conform to I.S. 1239 of Class specified and shall be heavy class. These may require to be connected to the existing/new CPVC/ DI Pipes. The pipe and fitting approved make, solvent etc., as required shall be used as per approved manufacture specification.

iii. SS 316 pipe shall be provided in labs and specific water supply requirements. The jointing shall be press type fittings with S-C contour in accordance with DVGW regulation W-524 with fittings. A press joint is made by mechanical deformation of the tube and fitting means of special hydraulic tool and cutting of pipe shall also be carried by later cutting tools by authorized agency. An elastomer o-ring is inserted in the recess at the end of the fitting for sealing. When the joint is made, the cross section of the tube becomes hexagonal. A calibration tool is used to ensure that the joint made is up to standard, Clearances from wall, floor and ceiling should be allowed for making the joint refer to the manual of the press tool for clearance requirements.

4.4.1. Galvanised Iron Pipes

i. 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.
ii. 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)

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

iv. All pipes shall be fixed in accordance with approved layout and alignment. Care shall be taken to avoid air pockets. G.I. 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 per approved drawings.

4.4.2. Ductile Iron Pipes

i. Pipe and fittings shall be joined with spigot and socket joints or flanged 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.

ii. Fittings shall be ductile iron of approved make. Each fitting shall have manufacturer’s trade mark stamped on it. Fittings for CPVC pipe shall include couplings, bends tees, reducers, nipples, union and bushes. Fittings shall conform to I.S. 8329.

iii. All pipes shall be fixed in accordance with approved layout and alignment. Care shall be taken to avoid air pockets. Pipes may be run as per approved drawings.

4.4.3. Chlorinated Polyvinyl Chloride (CPVC) pipes and fittings

i. CPVC pipes of specified dia. nominal bore shall conform to I.S. 15778 – 2007 and ASTM-F441 Schedule 40. The pipe fittings, clamps, etc. required for specified dia. bore pipes shall be of best quality and make as approved by the Engineer-in-charge. Chlorinated Polyvinyl Chloride (CPVC) pipes shall be as per ASTM-F441 Schedule 40 and having thermal stability for hot & cold water supply, including all CPVC plain & brass threaded fittings, including fixing the pipe with clamps at 1.00 m spacing. This includes jointing of pipes & fittings with one step CPVC solvent cement and testing of joints complete as per direction of Engineer in Charge.

a) 15mm
b) 20mm
c) 25mm
d) 32mm
e) 40mm
f) 50mm
g) 65 mm;

ii. Workmanship:- Pipes shall be cut either with a wheel type plastic pipe cutting or hacksaw blade and care shall be taken to make a square cut which provides optimal bonding area within a joint. Burrs and fittings should be removed from the outside and inside of pipe with a pocket knife or file. The tubing should make contact with the socket wall 1/3 or 2/3 of the way into the fitting socket. Only CPVC solvent cement confirming to ASTM-F493 should be used for joining pipe with fittings. An even coat of solvent cement should be applied on the pipe end and a thin coat inside the fitting socket. After applying the solvent cement on both pipe and fitting socket, pipe should be inserted into the fitting socket within 30 seconds, and rotating the pipe ¼ to ½ turn while inserting so as to ensure even distribution of solvent cement with the joint. The assembled system should be held for 10 seconds (approximately) in order to allow the joint to set.
up. An even bead of cement should be evident around the joint and if this bead is not continues remake the joint to avoid potential leaks.

When making a transition connection to metal threads, special Brass / plastic transition fitting (Male and female adapters) should be used. Plastic threaded connections should not be over torqued Hard tight puts one half turn should be adequate.

iii. Pipe and fittings shall be joined with one step CPVC solvent cement and testing of joints complete as per direction of Engineer in Charge.

iv. Fittings shall be CPVC of approved make. Each fitting shall have manufacturer’s trade mark stamped on it. Fittings for CPVC pipe shall include couplings, bends, tees, reducers, nipples, union and bushes and shall be of best make as approved by the Engineer-in-charge.

v. Only CPVC solvent cement conforming to ASTMF 493 should be used for joining pipe with fittings and valves. The cement solvent should be used within 30 days after opening the company’s seal and tightly close the seal after using in order to avoid its freezing. The freezed cement solvent should be discarded immediately and fresh one should be used.

vi. For horizontal runs, support should be given at 3 foot (90 cm) intervals for diameters of one inch and below and at 4 foot (m) intervals for larger sizes. Hangers should not have rough or sharp edges which come in contact with the tubing.

vii. All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. 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.

4.4.4. PVC (Sch40) Pipes & Fittings for water distribution Network

i. The rigid PVC (Polyvinyl Chloride) compound used in the manufacture of pipes and fittings is Type 1, i.e. Grade 1 PVC 1120 as identified in ASTM D 1784. The compound contains specified amounts of pigment, stabilizers and other additives to facilitate extrusion.

ii. The system is made as per ASTM (American Society for Testing of Materials) standards. The Pipes are made as per ASTM D 1785 and Fittings are made as per ASTM D 2466 (for SCH 40 Fittings). The pipes are plain ended in lengths of 3 meters in SCH 40 pressure classes.

iii. PRESSURE RATING – PVC SCHEDULE 40

<table>
<thead>
<tr>
<th>Norm Size (mm)</th>
<th>Max. Work Pre. at 23°C (kg/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>42.19</td>
</tr>
<tr>
<td>20</td>
<td>33.75</td>
</tr>
<tr>
<td>25</td>
<td>31.64</td>
</tr>
<tr>
<td>32</td>
<td>26.01</td>
</tr>
<tr>
<td>40</td>
<td>23.20</td>
</tr>
<tr>
<td>50</td>
<td>19.69</td>
</tr>
<tr>
<td>65</td>
<td>21.09</td>
</tr>
<tr>
<td>80</td>
<td>18.28</td>
</tr>
<tr>
<td>100</td>
<td>15.47</td>
</tr>
<tr>
<td>150</td>
<td>12.66</td>
</tr>
</tbody>
</table>
iv. Cut pipe square. As joints are sealed at the base of the fitting socket. An angled cut result in joint failure. Acceptable tools include miter saw, mechanical cut off saw or wheel cutter. Wheel type cutters must employ a blade designed for plastics.

v. Remove all burrs from inside and outside of pipe with a knife-edge, file, or deburring tool. Chamfer(bevel) the end of the pipe 10° - 15°.

vi. Remove surface dirt, grease, or moisture with a clean dry cloth.

vii. With light pressure, pipe should go one third to one half of the way into the fitting socket. Pipes and fittings that are too tight or too loose should not be used.

viii. Use an applicator that is one half the pipe diameter. Too large an applicator will force excessive cement into the inside of small diameter fittings. Too small an applicator will not apply sufficient cement to large diameter systems.

ix. Apply a full even layer of cement to the outside of a pipe and medium layer of cement to the inside of a fitting.

x. Assemble pipe and fitting socket till it contacts socket bottom. Give pipe a quarter turn. Hold pipe and fitting together until the pipe does not back out. Remove excessive cement from the exterior. A properly made joint will show a continuous bead of cement around the perimeter.

xi. Pressure Testing

a. Conduct pressure testing with water. DO NOT USE AIR OR OTHER GASES for pressure testing.

b. The piping system should be adequately anchored to limit movement. Water under pressure exerts thrust forces in piping systems. Thrust blocking should be provided at changes of direction, change in size and at dead ends.

c. Refer tables given for initial set & cure times before pressure testing.

d. The piping system should be slowly filled with water, taking care to prevent surge and air entrapment. The flow velocity should not exceed 1 feet per second.

e. All trapped air must be slowly released. Vents must be provided at all high points of the piping system. All valves and air relief mechanisms should be opened so that the air can be vented while the system is extremely dangerous and it must be slowly and completely vented prior to testing.

f. The piping system can be pressurized to 125% of its designed working pressure. However care must be taken to ensure the pressure does not exceed the working pressure of the lowest rated component in the system (valves, unions, flanges, threaded parts etc.)

g. The pressure test should not exceed one hour. Any leaking joints or pipe must be cut out and replaced and the line recharged and retested using the same procedure.

4.4.5. Clamps

i. G.I/CPVC/SS pipes / D.I. 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

4.4.6. 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.

4.4.7. Flanges

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

ii. 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.

4.4.8. 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

All D.I./G.I. pipes in trenches shall be protected with fine sand 15 cm all around before filling in the trenches.

4.4.9. 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.

4.4.10. Pipe protection

i. All G.I. 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 D.I./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 (Pykpote)

4.4.11. Insulation

Hot water pipes within a toilet/kitchen, shaft and terrace from hot water header shall be insulated with nitrile rubber insulation on hot water supply of required size as per specifications.

i. Materials:

Insulation material for Pipe insulation shall be Closed Cell Elastomeric Nitrile Rubber or closed cell cross linked polyethylene foam. Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.038 W/mK or 0.0313 Kcal / Mhr oC or 0.212 BTU / (Hr-ft2-oF/inch) at an average temperature of 30oC. The product shall have temperature range of −40 oC to 105oC. Density of material shall not be less than 0.06 gm/cm3. The insulation shall have fire performance such that it passes minimum CLASS 1 as per BS476 part 7 for surface spread of
flame. Water vapour permeability shall not exceed 0.024 per m inch (3 x 10^{-14} Kgs / m.sec.Pa).

ii. **Workmanship:**

Insulating material in tube form shall be sleeved on the pipes. On existing piping, slit opened tube from insulating material shall be placed over the pipe and adhesive (as recommended by the manufacturer) shall be applied as suggested by the manufacturer. Adhesive must be allowed to tack dry and then press surface firmly together starting from butt end and working towards centre.

All insulation work shall be carried out by skilled workmen specially trained in this kind of work. All insulated pipes shall be labelled (HWS / HWR / HWRR) and provided with 300 mm wide band of paint along circumference at every 1200 mm for colour coding. Direction of fluid shall also be marked. All painting shall be as per relevant BIS codes.

### 4.5 Valves

i. **Ball valves**

Providing and fixing ball valve (Gunmetal) of approved quality, High or low pressure, with plastic floats as per drawings/CPWD specifications and directions of Engineer-in-charge. Valves below 50 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 couplings and steel handles to B.S. 5351.

ii. **Butterfly Valve**

a. The Butterfly valve shall be of best quality as per CPWD specification with hand lever operation. Operating pressure not less than 16 Kg/Sq.cm (PN 16). The Butterfly valve shall confirm to IS:13095.

b. Valves 50 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. Butterfly valve shall be of best quality conforming to IS: 13095.

c. The butterfly valve shall be installed with rubber gasket, flanges, nuts, bolts, washers & painting complete as required as approved by the Engineer-in-charge and as per CPWD specifications. The Butterfly Valve shall be complete with bolts, nuts, washers and neoprene gaskets as per manufacturers specifications.

iii. 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.N1.6

iv. 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.

v. Sluice valve shall be of approved makes conforming to I.S.:780 of class as specified.

### 4.6 Storage Tanks

#### 4.6.1 Overhead Tanks

Overhead water storage tanks for water supply shall be reinforced cement concrete/PVC, as per design approved by the Engineer-In-Charge.

#### 4.6.2 Tank connection and accessories

i. Contractor shall provide the following to each tanks:

   a. Inlet and outlet connections to pumps, equipment and main pipe lines.
b. Tank overflows with mosquito proof gratings

c. Scour drain and valve as per drawings

d. 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 co-operate with the contractor to ensure that the work is successfully executed.

4.7. 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.

4.8. P.P. soil, waste water and ventilating pipes & Fittings:

4.8.1. Pipes

i. The specified size of P.P. soil or waste pipe shall conform EN 12056. The soil, waste water and ventilating pipes shall be of the following Normal size (A) 110 mm. dia. (B) 160 mm. dia., unless otherwise required as per design.

ii. Workmanship:

The pipes shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth, clean, free from groovings and other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be laid and clamped to wooden plugs fixed above the surface of the wall. Alternatively plastic clamps of suitable designs shall be preferred. Jointing for P.P. pipes shall be made by means of ‘O’ rubber ring.

All soil pipes shall be carried up above the roof and shall have a wire balloon guard or a cowl.

The ventilating pipe or shaft shall be carried out to a height of at least one meter above the outer covering of the roof of the building.

The P.P. pipes shall be fixed with M. S. clamps and stays. The clamp shall be made from 1.5 mm. thick M. S. flat or 3 mm. width band to the required shape and size to fit tightly on the sockets when tightened with screw bolts. It shall be formed of two semicircular pieces with flanged ends on both sides; with holes to fit in the screw bolts and nut 40 mm. dia. M. S. Bars. One end of the stay shall be bent to from a hook to be fixed with clamps by means of bolts and the other end shall be bent for embedding in wall in cement concrete block of size 200 mm. x 100 mm. x 100 mm. in 1:2:4 mix. The concrete shall be finished to match the surrounding surfaces.
The connection between the main pipe and branch pipes shall be made by using branches and bends with access doors for cleaning.

The waste from lavatories, kitchens basins, sinks, baths and other floor traps shall be separately connected to respective stacks of upper floors. The waste stack of lavatories shall be connected directly to main hole while the waste slack of other shall be separately discharged over gully trap.

4.8.2. P.P. P trap:

i. The P.P. P trap shall conform to EN 12056. The SS hinged grating shall be of best quality. P.P. P trap shall be of the 110 mm nominal diameter or as per design of self-cleaning design with hinged grating including cost of cutting and making good the walls and floors.

ii. Workmanship:

The P Trap with 110 mm. dia. inlet and 110 mm. dia. outlet shall be fixed as per drawing or as directed. The P trap shall be jointed with P.P. pipe, 110 mm. dia. with solvent cement joints.

4.8.3. PP Floor Drain:

i. The PP Fittings shall conform to EN : 12056. The PP Floor Drain shall be of the of 110 x 50 mm size or as per design including cost of cutting and making good the floors.

ii. Workmanship:

The Floor drain shall be made out of PP elbow of 110mm x 110 mm and 110 mm x 50 mm reducer size with setting in 1:2:4 mix cement concrete block or clamping to the wall or suspending with the ceiling including cutting and making good the walls and floors wherever required. The Floor drain shall be jointed with pipe with solvent cement joints.

4.8.4. PP soil, waste water and ventilating pipes :

i. The specified size of PP soil or waste pipe shall conform EN : 12056. The PP soil, waste water and ventilating pipes shall be of the following normal size (A) 40 mm. dia. (B) 50 mm. dia.(C) 63 mm. dia.

ii. Workmanship:

The pipes shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth, clean, free from groovings and other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be laid and clamped to wooden plugs fixed above the surface of the wall. Alternatively plastic clamps of suitable designs shall be preferred. Jointing for PP pipes shall be made by means of ‘O’ rubber ring.

The waste from lavatories, kitchens basins, sinks, baths and other floor traps shall be separately connected to respective stacks of upper floors. The waste stack of lavatories shall be connected directly to main hole while the waste slack of other shall be separately discharged over gully trap.

4.8.5. PP Clean out Plug :

i. The PP Fittings shall conform to EN:12056. The PP Clean out Plug shall be of nominal size (A) 110 mm. dia.(B) 160 mm. dia.

ii. Workmanship:

The Clean Out plug shall be made out of PP coupler with access door of suitable size. The Clean out Plug shall be jointed with pipe with ‘O’ rubber ring.

4.9. CP Materials:

4.9.1. CP Brass Angle Valve:

i. The C. P. brass Angle Valve shall be 15/20mm dia. of best quality as approved by the Engineer-in-charge. The Angle Valve shall conform to I.S. 8931-1993.
CP brass Angle Valve shall be with PVC flexible connections 1.5m long or as per requirement of standard design and of approved make.

ii. Workmanship:- The C.P. brass Angle Valve shall be fixed as directed to 15/20 mm. dia. CPVC. at one end and PVC flexible connection with brass check nut on the other end.

4.9.2. CP Brass wall mixer:-

i. The Wall Mixer shall conform to I.S. 8931-1993. The CP Brass wall mixer shall be with provision of overhead shower with 115mm long bend pipes on upper side with connecting legs and wall flanges with all accessories as required and making good the walls wherever required. The C. P. brass Wall Mixer shall be 15mm dia. of best quality as approved by the Engineer-in-charge.

ii. Workmanship:- The C.P. brass wall Mixer shall be fixed as directed to 15 mm. dia. CPVC. at the inlet.

4.9.3. C. P. brass towel rail:-

i. The C. P. brass towel rail, 600mm long and 20 mm dia, shall be of best quality as approved by the Engineer-in-charge. The brackets shall be of C. P. brass. The rail shall conform to I.S. 1068-1958. The C. P. brass towel rail complete with C. P. brass brackets shall be fixed to wooden plugs and C. P. brass screws.

ii. Workmanship: The brackets of the towel rail shall be fixed by means of C.P. brass to screws wooden plugs finely embedded in the wall with C.M. 1 : 3 (1 cement: 3 coarse sand). The towel rail shall be fixed as and where directed.

4.9.4. CP Brass Soap Dish:-

i. The C. P. brass Soap Dish shall be of best quality as approved by the Engineer-in-charge. The CP Brass Soap Dish complete with C. P. brass brackets shall be fixed to wooden plugs with and C. P. brass screws.

ii. Workmanship:- The C.P. brass Soap Dish shall be fixed by means of C.P. brass to screws wooden plugs finely embedded in the wall with C.M. 1 : 3 (1 cement: 3 coarse sand). The towel rail shall be fixed as and where directed.

4.9.5. CP Brass Liquid Soap Dispenser:-

i. Liquid Soap Dispenser shall be wall/counter mounted suitable for dispensing liquid soaps, lotions, detergents. The cover shall lock to body with concealed locking arrangement, opened only by key provided. Liquid soap dispenser body and shank shall be of high impact resistance material. The piston and spout shall be stainless steel with 1 litre capacity polyethylene container. The valve shall operate with less than 2.27 Kg (5 lbs) of force. CP Brass Liquid Soap Dispenser complete with C. P. brass brackets shall be fixed to wooden plugs with and C. P. brass screws.

ii. Workmanship:- The C.P. brass Liquid Soap Dispenser shall be fixed by means of C.P. brass to screws wooden plugs finely embedded in the wall with C.M. 1 : 3 (1 cement: 3 coarse sand).

4.9.6. 32 mm dia. C.P. brass waste coupling for sink

i. The 32 mm dia. C.P. brass waste trap and unions shall be of best quality and make as approved by the Engineer-in-charge.

ii. Workmanship:- C. P. brass waste trap and union shall be connected to 32 mm. dia. waste pipe which shall be suitably bent towards the wall and which shall discharge into drain through a floor trap. The C. P. brass waste trap shall be provided for wash basin or sink as the case may be.

4.9.7. CP Brass Sink mixer
i. The C. P. brass Sink Mixer shall be 15mm dia. of best quality as approved by the Engineer-in-charge. The CP Brass Sink mixer shall be with casted swinging spout with all accessories as required and making good the walls wherever required.

ii. Workmanship: The C.P. brass sink mixer shall be fixed as directed to 15 mm. dia. CPVC. Pipe at one end.

4.9.8. Fully automatic "NO TOUCH" durable & shock proof hand drier:

i. The hand drier shall be no touch operating type with solid state time delay to allow user to keep hand in any position. The hand drier shall be fully hygienic, rated for continuous repeat use (CRU). The rating of hand drier shall be such that time required to dry a pair of hands up to wrists is approximately 30 seconds. The hand drier shall be of wall mounting type suitable for 230 V, single phase, 50 Hz, AC power supply. It shall be fully automatic "NO TOUCH" durable & shock proof hand drier of approved make & manufacture suitable to operate on 220 volts, single phase 50 Hz, A.C. power supply, 1500 Watt and directly plugged to power point complete in ABS plastic body having drying time 20-30 seconds complete as per direction of Engineer in Charge.

ii. Workmanship: The Hand Drier shall be fixed by means of C.P. brass to screws wooden plugs finely embedded in the wall with C.M. 1 : 3 (1 cement: 3 coarse sand). The towel rail shall be fixed as and where directed.

4.9.9. Health faucet with regulator

i. The Health Faucet shall be 15mm dia. of best quality as approved by the Engineer-in-charge. The Health faucet shall be with regulator with flexible pipe 1 m long, wall hooked complete as required.

ii. Workmanship: The Health Faucet shall be fixed as directed to 15 mm. dia. CPVC. Pipe at one end, as and where directed.

4.9.10. Hand rail and grab bar

i. The C. P. brass hand rail shall be 600 x 20 mm. of best quality as approved by the Engineer-in-charge. The brackets shall be of C. P. brass. The rail shall conform to I.S. 1068-1958. hand rail size 600X100mm and grab bar 350mm long to mounted on the track (vertically and laterally) for handicap toilet complete as required.

ii. Workmanship: The brackets of the hand rail shall be fixed by means of C.P. brass to screws wooden plugs finely embedded in the wall with C.M. 1 : 3 (1 cement: 3 coarse sand), as and where directed.

4.9.11. CP Brass Robe Hook

i. The C. P. brass Robe Hook shall be of best quality as approved by the Engineer-in-charge. The CP Brass Robe Hook shall be complete with C.P brass brackets fixed to wooden plugs with and C. P. brass screws.

ii. Workmanship: The C.P. brass Robe Hook shall be fixed by means of C.P. brass to screws wooden plugs finely embedded in the wall with C.M. 1 : 3 (1 cement: 3 coarse sand), as and where directed.

4.10. Other Materials

4.10.1. S.S. hinged grating

i. The 100 mm. dia. SS hinged gratings for Floor trap shall be of best quality and make as approved. The frame of the grating shall be minimum 6mm thick. The S.S. hinged grating, 6mm thick with frame shall be of approved make including setting in floor with cement mortar 1:3 mix

ii. Workmanship: The SS grating shall be provided to P trap as the case may be in best workman like manner.

4.10.2. Nitrile rubber insulation on hot water supply
i. Insulation material for Pipe insulation shall be Closed Cell Elastomeric Nitrile Rubber or closed cell cross linked polyethylene foam. Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.038 W/mK or 0.0313 Kcal / Mhr oC or 0.212 BTU / (Hr-ft2-oF/inch) at an average temperature of 30oC. The product shall have temperature range of -40 oC to 105oC. Density of material shall not be less than 0.06 gm/cm3. The insulation shall have fire performance such that it passes minimum CLASS 1 as per BS476 part 7 for surface spread of flame. Water vapour permeability shall not exceed 0.024 perm inch (3 x 10-14 Kgs / m.sec.Pa). The nitrile rubber insulation shall be on hot water supply of the following size as per specifications. (A) 15 mm; (B) 20 MM; (C) 25 mm; (D) 32 mm; (E) 40 mm; (F) 50 mm; (G) 65 mm; (H) 80 mm.

ii. Workmanship:

Insulating material in tube form shall be sleeved on the pipes. On existing piping, slit opened tube from insulating material shall be placed over the pipe and adhesive (as recommended by the manufacturer) shall be applied as suggested by the manufacturer. Adhesive must be allowed to tack dry and then press surface firmly together starting from butt end and working towards centre.

All insulation work shall be carried out by skilled workmen specially trained in this kind of work. All insulated pipes shall be labelled (HWS / HWR / HWRR) and provided with 300 mm wide band of paint along circumference at every 1200 mm for colour coding. Direction of fluid shall also be marked. All painting shall be as per relevant BIS codes.

4.10.3. MS pipe puddle flanges

Providing and fixing for water tanks MS pipe puddle flanges of required size with 6mm thick MS plate of required size properly fixed in RCC walls of water tanks, including necessary welding of pipe with MS plate & reinforcement as per drawings and directions of Engineer-in-charge.

4.10.4. UPVC Rain Water pipes

i. The specified size of uPVC Spigot and socket soil or waste pipe shall conform IS 4985 – 2000 the UPVC Rain Water pipes shall be of the following normal size

(A) 160 mm. dia.
(B) 200 mm. dia.

ii. Workmanship:

The pipes shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth, clean, free from groovings and other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be laid and clamped to wooden plugs fixed above the surface of the wall. Alternatively plastic clamps of suitable designs shall be preferred. Jointing for UPVC pipes shall be made by means of solvent cement for horizontal lines and ‘O’ rubber ring for vertical line.

The waste from lavatories, kitchens basins, sinks, baths and other floor traps shall be separately connected to respective stacks of upper floors. The waste stack of lavatories shall be connected directly to main hole while the waste slack of other shall be separately discharged over gully trap.

4.10.5. Cast Iron grating

i. The 225 x 225 mm. Cast Iron gratings for Floor trap shall be of best quality and make as approved. The Cast Iron grating, with frame shall be of an approved make including setting in floor with cement mortar 1:3.

ii. Workmanship: The grating shall be provided to Rain Water Pipes as the case may be in best workman like manner.

4.10.6. MS grating
i. **MS grating consisting of ISI marked MS frame made of angle size 25mm x 25mm x 4mm thick. The removable cover shall be made out of ISI marked MS angle size 25mm x 25mm x 4mm thick having vertically welded transverse members made out of MS flats of size 25mm x 5mm thick at a spacing of 25mm centre to centre. The MS grating, with frame shall be of an approved make including setting in floor with cement mortar 1:3.**

ii. **The grating to be fixed on brick / concrete with 2 nos hold fasts of size 100mm x 25mm x 4mm thick to be embedded with cement concrete block of size 150mm x 100mm x 100mm of mix 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20mm nominal size) on each face of wall including painting with two coats of synthetic enamel paint over a coat of primer complete as per direction of engineer - in - charge.**

### 4.10.7. Reinforced Concrete Light Duty Non-Pressure Pipes

i. **The reinforced concrete light duly non - pressure pipes of specified diameter shall conform to I.S. 458-1971. The laying to level or slopes and jointing reinforced concrete light duty non-pressure pipes I.S. class N.P. 2 of the 200mm internal diameters shall be with collars and butt-ended prepared for collar joints incl. testing of joints etc. complete**

ii. **Laying:**

The pipes shall be lowered into the trenches carefully. Mechanical appliances may be used. Where necessary pipe shall be laid in straight lines or with easy curves and true to line and gradient as specified. The laying of pipe shall proceed upgrade of a slope. In the pipe with loose collars, the collars shall be slipped on before the next pipe is laid.

In case where the foundation conditions are unusual such as the proximity of trees or holes, under existing or proposed around in 150 mm. thick cement concrete 1 :5 :10 (1 cement: 5 fine sand : 10 graded stone aggregate 40 mm. nominal size) or compacted sand or gravel.

In case where the natural foundation is inadequate the pipe shall be laid either in concrete cradle, supported on proper foundation or on any other suitably designed structure. If concrete bedding is used, the depth of concrete below bottom of the pipe shall be at least ¼th of the internal diameter of the pipe subject to a minimum of 100 mm. and maximum 300 mm. The concrete shall be extended upto the sides of the pipe at least a distance of ¼ th of the outside diameter for pipes 300 mm. and over in diameter.

The pipes shall be laid in the concrete bedding before the concrete has set. Pipe laid in trenched in earth shall be bedded evenly and firmly and as far as upto the haunches of the pipe as to safely transmit the load expected from the back fill through the pipe to the bed. This shall be done either by excavating the bottom of the trenches to fit the curve of the pipe or by compacting the earth under round curve of the pipe to form an even bed. Necessary provision shall be made for joints wherever required.

iii. **Jointing:**

The joints shall be done by slipping the collar over and clear of the end of the pipe. The recess of the end of the pipe shall be filled with jute threading dipped in hot bitumen. The new pipe shall then be brought forwarded until the bitumen ring in recess of first pipe is set into the recess of the second pipe. This process shall be repeated for two or three pipes which shall then be jacked up so as to thoroughly compress the bitumen. The quantity of jute and bitumen shall be just enough to fill the recess when pressed hard by jacking, care being taken that no offset of the jute braiding shall be visible either outside or inside of pipe. The collar shall then be set up over the joints covering equally both the pipe and leaving an even caulking space all round Cement and sand mortar 1 : 1½ shall then be well punched or pressed home with a caulking tool within this caulking
space. Care shall be taken that the underside of the joints is properly filled with mortar.

iv. Curing:
Every joint shall be kept wet for about 10 days for maturing, the section of the pipe line laid and jointed shall be covered immediately to protect from weather effects. Minimum bore of 100 mm. is considered adequate. 2 A2. The joints shall be left exposed for observation.

v. Testing of joints: The testing of joints shall be done as per relevant specifications.

4.10.8. 455x610 mm rectangular C.I. cover with (light duty)
i. The cover for the OHT shall be 455x610 mm rectangular C.I. cover with frame (light duty), with weight not less than 15 Kg for frame and 23 Kg for cover confirming to IS:1726 -1991.

ii. Workmanship: The CI Cover shall be securely placed on the top of the overhead tank as the case may be in best workman like manner.

4.10.9. Grease Trap
i. The grease trap shall be constructed in brick masonry chamber with three chambers, each of 0.4 M X 0.6 M in plan including constructing baffle wall, stainless steel angles on corners, stainless steel perforated plates with stainless steel lifting handles in each chamber, inlet and outlet fittings, double seal C.I. covers complete as per standard design. The brick masonry water tight grease trap shall be with inside size 2.0m x 1.5m and 1.0m deep including two nos. 60x60 cm. C.I. Cover and frame (double seal weight of cover and frame not less than 75 kg).

ii. Workmanship:
   a. Bed Concrete shall be in 1:4:8 cement concrete 150 mm thick.
   b. Brick work shall be with best quality bricks in 1:5 cement mortar. Baffle walls shall be of R.C.C and of size as mentioned in DBR/Drawings. Brick partition constructed of best quality table moulded bricks in cement mortar 1:5 shall be provided for the entire height of chamber. The walls of chamber shall be plastered from inside with 12 mm thick cement plaster 1:3 and finished smooth with a floating coat of neat cement & rough plaster on outside in cement mortar 1:3.
   c. Chamber Covers shall be of size and duty as mentioned in DBR/Drawings. Covers shall be of cast iron as per the details given in the drawing and shall be fixed on frame embedded in concrete. C. I steps shall be provided at two corners of the chamber. All Cast Iron and MS items shall be painted with two coats of bitumastic paint.
   d. Cast iron Manhole covers and Frame shall conform to IS: 1726 and the grade and types have been specified in the DBR/Drawings. The cover and frames shall be cleanly cast and they shall be free from air and sand holes and from cold shuts. They shall be neatly dressed and carefully trimmed. All castings shall be free from voids whether due to shrinkage, gas inclusion or other causes. Covers shall have a raised chequered design on the top surface to provide an adequate non-slip grip. The sizes of covers specified shall be taken as the clear internal dimensions of the frame. The covers and frames shall be coated with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to a temperature of 63° C and shall not brittle as to chip off at a temperature of 0° C.

5. LAYING AND JOINTING OF SEWER AND DRAIN PIPES AND FITTINGS
   a) All the Strom Water Piping shall be RCC NP2/NP3 with bedding and upto hunch level with 1:5:10 (40mm aggregate).
b) All the Sewer and ETP external piping shall be of uPVC SN4 with all around concreting with 1:5:10 (40mm aggregate).

5.1. UNLOADING :
(a) The pipes shall be unloaded where they are required.
(b) Unloading (except where mechanical handling facilities are available) – pipes weighing up to 60 kg shall be handled by two persons by hand passing. Heavier pipes shall be unloaded from the lorry or wagon by holding them in loops, formed with ropes and sliding over planks set not steeper than 45 degrees. The planks shall be sufficiently rigid and two ropes shall always be used to roll the pipes down the planks. The ropes should be tied on the side opposite the unloading. Only one pipe shall be unloaded at a time.
(c) Under no circumstances shall the pipes be thrown down from the carriers or be dragged or rolled along hard surfaces.
(d) The pipes shall be checked for any visible damage (such as broken edges, cracking or spalling of pipe) while unloading and shall be sorted out for reclamation. Any pipe which shows sufficient damage to preclude it from being used shall be discarded.

5.2. STORING :
(a) The pipes and specials shall be handled with sufficient care to avoid damage to them. These shall be lined up on one side of the alignment of the trench socket facing upgrade when line runs uphill and upstream when lines run on level ground.
(b) Each stack shall contain pipes of same class and size, consignment or batch number and particulars of the suppliers, wherever possible, shall be marked on the stack.
(c) Storage shall be done on firm, level and clean ground. Wedges shall be provided at the bottom layer to keep the stack stable.

5.3. CUTTING :
(a) Cutting of pipes may be necessary when pipes are to be laid in lengths shorter than the lengths supplied, such as while replacing accessories like tees, bends, etc. at fixed position in the pipe lines.
(b) A line shall be marked around the pipe with a chalk piece at the point where it is to be cut. The line shall be so marked that the cut is truly at right angle to the longitudinal axis of the pipe.

5.4. TRENCHES :
(a) The trenches shall be so dug that the pipes may be laid to the required alignment and at required depth.
(b) The minimum width of the trench should be “D + 400 mm”, where, D is outer diameter of the pipe.
(c) The bed of the trench, if in soft or made up earth, shall be well watered and rammed before laying the pipes and the depressions, if any, shall be properly filled with earth and consolidated in 20 cm layer.
(d) If the trench bottom is extremely hard or rocky or loose stony soil, the trench shall be excavated at least 150 mm below the trench grade. Rocks, stone or other hard substances from the bottom of the trench shall be removed and the trench brought back to the required grade by filling with selected fine earth or sand (or fine morum if fine soil or sand is not available locally) and compacted so as to provide a smooth bedding for the pipe or provide lean cement concrete as required and specified.
(e) After the excavation of the trench is completed, hollows shall be cut at the required position to receive the socket of the pipes and these hollows shall be of sufficient depth to ensure that the barrels of the pipes shall rest throughout their
entire length on the solid ground and that sufficient spaces left for jointing the underside of the pipe joint. These socket holes shall be refilled with sand after jointing the pipe.

(f) Roots of trees within a distance of about 0.5 meter from the side of the pipe line shall be removed or killed.

(g) The excavated materials shall not be placed within 1 meter or half of the depth of the trench, whichever is greater, from the edge of the trench. The materials excavated shall be separated and stacked so that in refilling that may be re-laid and compacted in the same order to the satisfaction of the Engineer-in-charge.

(h) The trench shall be kept free from water. Shoring and timbering shall be provided wherever required. Excavation below water table shall be done after dewatering the trenches.

(i) Where the pipe line or drain crosses an existing road, the road crossing shall be excavated half at a time, the 2nd half being commenced after the pipes have been laid in the first half and the trench refilled. Necessary safety measures for traffic as directed shall be adopted. All types, water main cables, etc. met within the course of excavation shall be carefully protected and supported. Care shall be taken not to disturb the electrical and communication cable met with during course of excavation, removal of which, if necessary, shall be arranged by the Engineer-in-charge.

(j) When pipes are laid under road and pavements, subjected to heavy traffic loads, the trench may be covered with RCC slabs of suitable dimensions.

5.5. LAYING :

(a) The pipes shall be lowered into the trench by means of suitably pulley blocks, sheer legs chains ropes etc. In no case the pipes shall be rolled and dropped into the trench. One end of each rope may be tied to a wooden or steel peg driven into the ground and the other end held by men which when slowly released will lower the pipe into the trench. After lowering, the pipes shall be arranged so that the spigot of one pipe is carefully centered into the socket of the next pipe, and pushed to the full distance that it can go. The pipe line shall be laid to the levels required. Specials shall also be laid in their proper position as stated above.

(b) Where so directed, the pipes and specials may be laid on masonry or concrete pillars. The pipe laid on the level ground, shall be laid with socket facing the direction of flow of water.

(c) In unstable soils, such as soft soils and dry lumpy soils it shall be checked whether the soils can support the pipe lines and if required suitable special foundation shall be provided.

5.6. BACK FILLING AND TAMPPING :

(a) Back filling shall follow pipe installation as closely as possible to protect pipe from falling boulders, eliminating possibility of lifting of the pipe due to flooding of open trench and shifting pipe out of line by caved in soil.

(b) The initial back fill material used shall be free of large stones and dry lumps.

(c) The initial back fill shall be placed evenly in a layer of about 100 mm thick. This shall be properly consolidated and this shall be continued till there is a cushion of at least 300 mm of cover over the pipe.

(d) If it is desired to observe the joint or coupling during the testing of mains they shall be left exposed. Sufficient back fill shall be placed on the pipe to resist the movement due to pressure while testing.

5.7. S. W. GULLY TRAP

5.7.1. MATERIAL :
Gully traps shall conform to IS: 651. These shall be sound, free from visible defects such as fire cracks, or hair cracks. The glaze of the traps shall be free from crazing. They shall give a sharp clear tone when struck with light hammer. There shall be no broken blisters.

Each gully trap shall have one C.I. grating of square size corresponding to the dimensions of inlet of gully trap. It will also have a water tight C.I. cover with frame inside dimensions 300 x 300 mm the cover weighing not less than 4.50 kg and the frame not less than 2.70 kg. The grating, cover and frame shall be of sound and good casting and shall have truly square machined seating faces.

5.7.2. EXCAVATION:

The excavation for gully traps shall be done true to dimensions and levels as indicated on plans or as directed by the Engineer-in-charge.

5.7.3. FIXING:

The gully trap be fixed over cement concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size) foundation 650 mm square and 100 mm thick. The jointing of gully outlet to the branch drain shall be done similar to jointing of S.W. pipes as described above.

5.7.4. BRICK MASONRY CHAMBER:

After fixing and testing gully and branch drain, a brick masonry chamber 300 mm x 300 mm (in side) with bricks in cement mortar 1:5 (1 cement : 5 fine sand) shall be built with a 100 mm brick work round the gully trap from the top of the bed concrete upto ground level. The space between the chamber walls and the trap shall be filled with cement concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 10 nominal size). The upper portion of the chamber i.e. above the top level of the trap shall be plastered in side with cement mortar 1:3 (1 cement : 3 sand), finished with a floating coat of neat cement. The corners and bottoms of the chamber shall be rounded off so as to slope towards grating.

C.I. cover with frame 300 mm x 300 mm (inside) size small then be fixed on the top of the brick masonry with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) 40 mm thick and rendered smooth. The finish top of the cover shall be left about 40 mm above the adjoining ground level so as to exclude the surface water from entering the gully trap.

5.8. REINFORCED CEMENT CONCRETE (RCC) PIPES (NP2 / NP3)

All NP2 / NP3 RCC pipes shall be spigot and socket end pipes. The ends shall be suitable for rubber ring joints. The pipes shall be ISI marked as per IS:458:2003. The rubber rings shall confirm to IS 5382.

5.8.1. MATERIAL:

General - The pipes shall be with reinforcement and shall be of the specified class. These shall conform to IS : 458 amended up to date. The reinforced cement concrete pipes shall be manufactured by centrifugal (or spun) process. All pipes shall be true to shape, straight, perfectly sound and free from cracks and flaws. The external and internal surface of the pipes shall be smooth and hard. The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding.

Concrete - The concrete quality shall be as per IS: 456 for at least very severe environmental exposure condition. Concrete used for the manufacture of reinforced concrete pipes shall have minimum cement content of 450 kg/cum and a compressive strength not less than 35 N/sq.mm at 28 days.

Aggregates - The aggregate shall confirm to 3 of IS : 383. The maximum size of aggregate should not exceed one third of the thickness of the pipe or 20 mm whichever is smaller for pipes above 250 mm dia and 10 mm size for pipe dia from 80 to 250 mm.
**Reinforcement** - The reinforcement shall confirm to mild steel grade 1 or medium tensile steel bars confirming to IS:432 (part 1) or hard drawn steel wire confirming to IS : 432 (part 2) or structural steel (standard quality) bars confirming to IS : 2062. The reinforcement in the reinforced concrete pipes shall extend throughout the length of the pipe. The circumferential and longitudinal reinforcements shall be adequate to withstand the specified hydrostatic pressure and further bending stresses due to the weight of water when running full across a span equal to the length of pipe plus three times its own weight.

5.8.2. **JOINTING : SPIGOT AND SOCKET JOINT :**

The spigot of each pipe shall be slipped home well into the socket of the pipe previously laid and adjusted in the correct position. The jointing of pipe shall be done by rubber ring method. The rubber rings shall confirm to IS : 5382.

A rubber ring shall be placed on the spigot which shall be forced into the socket of pipe previously laid. This compresses the rubber ring as it rolls into the annular space formed between the two surfaces of the spigot and socket, stiff mixture of cement and mortar 1:2 ( 1 cement : 2 fine sand) shall then be filled into the remaining annular space and rammed with a caulking tool. After days work any extraneous material shall then be removed from inside of the pipe and the newly made joint shall be cured.

5.8.3. **CLASS NP2 – REINFORCED CONCRETE LIGHT DUTY, NON PRESSURE PIPES**

<table>
<thead>
<tr>
<th>Internal Diameter of Pipes Nominal (mm)</th>
<th>Barrel Wall Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>25</td>
</tr>
<tr>
<td>100</td>
<td>25</td>
</tr>
<tr>
<td>150</td>
<td>25</td>
</tr>
<tr>
<td>200</td>
<td>25</td>
</tr>
<tr>
<td>225</td>
<td>25</td>
</tr>
<tr>
<td>250</td>
<td>25</td>
</tr>
<tr>
<td>300</td>
<td>30</td>
</tr>
<tr>
<td>350</td>
<td>32</td>
</tr>
<tr>
<td>400</td>
<td>32</td>
</tr>
<tr>
<td>450</td>
<td>35</td>
</tr>
<tr>
<td>500</td>
<td>35</td>
</tr>
<tr>
<td>600</td>
<td>45</td>
</tr>
<tr>
<td>700</td>
<td>50</td>
</tr>
<tr>
<td>800</td>
<td>50</td>
</tr>
<tr>
<td>900</td>
<td>55</td>
</tr>
<tr>
<td>1000</td>
<td>60</td>
</tr>
</tbody>
</table>

5.8.4. **CLASS NP3 – REINFORCED CONCRETE MEDIUM DUTY, NON PRESSURE PIPES**

<table>
<thead>
<tr>
<th>Internal Diameter of Pipes (mm)</th>
<th>Barrel Wall Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>25</td>
</tr>
<tr>
<td>200</td>
<td>30</td>
</tr>
<tr>
<td>225</td>
<td>30</td>
</tr>
<tr>
<td>250</td>
<td>30</td>
</tr>
<tr>
<td>300</td>
<td>40</td>
</tr>
<tr>
<td>350</td>
<td>75</td>
</tr>
<tr>
<td>400</td>
<td>75</td>
</tr>
<tr>
<td>450</td>
<td>75</td>
</tr>
<tr>
<td>500</td>
<td>75</td>
</tr>
<tr>
<td>600</td>
<td>85</td>
</tr>
<tr>
<td>700</td>
<td>85</td>
</tr>
</tbody>
</table>
5.9. **uPVC SN4 Pipe For Sewer and ETP Drain**

The specified size of uPVC Spigot and socket soil or waste pipe shall conform IS : 15328-2000 the UPVC Rain Water pipes shall be of the following normal size

(A) 160 mm. dia.

(B) 200 mm. dia.

(C) 250 mm. dia.

(D) 315 mm. dia.

5.10. **Workmanship:**

The pipes shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth, clean, free from groovings and other defects. The ends shall be cleanly cut and square with the axis of the pipe. Jointing for UPVC pipes shall be made by means of solvent cement for horizontal lines and ‘O’ rubber ring.

5.11. **TRENCHES :**

(i) The trenches shall be so dug that the pipes may be laid to the required alignment and at required depth.

(ii) Cover shall be measured from top of pipe to the surface of the ground.

(iii) The width of the trench shall be D+400 mm with a minimum of 750 mm. (D= External diameter of pipe). Note : The width should not be more than the mentioned for structural safety of the pipes.

(iv) The bed of the trench, if in soft or made up earth, shall be well watered and rammed before laying the pipes and the depressions, if any, shall be properly filled with earth and consolidated in 20 cm layer.

(v) If the trench bottom is extremely hard or rocky or loose stony soil, the trench shall be excavated at least 150 mm below the trench grade. Rocks, stone or other hard substances from the bottom of the trench shall be removed and the trench brought back to the required grade by filling with selected fine earth or sand (or fine moorum if fine soil or sand is not available locally) and compacted so as to provide a smooth bedding for the pipe.

(vi) After the excavation of the trench is completed, hollows shall be cut at the required position to receive the socket of the pipes and these hollows shall be of sufficient depth to ensure that the barrels of the pipes shall rest throughout their entire length on the solid ground and that sufficient spaces left for jointing the underside of the pipe joint. These socket holes shall be refilled with sand after jointing the pipe.

(vii) Roots of trees within a distance of about 0.5 meter from the side of the pipe line shall be removed or killed.

(viii) The excavated materials shall not be placed within 1 meter or half of the depth of the trench, whichever is greater, from the edge of the trench. The materials excavated shall be separated and stacked so that in refilling that may be re-laid and compacted in the same order to the satisfaction of the Engineer-in-charge.
(ix) The trench shall be kept free from water. Shoring and timbering shall be provided wherever required. Excavation below water table shall be done after rewatering the trenches.

(x) Where the pipe line or drain crosses an existing road, the road crossing shall be excavated half at a time, the 2nd half being commenced after the pipes have been laid in the first half and the trench refilled. Necessary safety measures for traffic as directed shall be adopted. All types, water main, cables, etc. met within the course of excavation shall be carefully protected and supported. Care shall be taken not to disturb the electrical and communication cable met with during course of excavation, removal of which, if necessary, shall be arranged by the Engineer-in-charge.

5.12. LAYING:

Pipes shall be lowered into the trench carefully. Mechanical appliances may be used, where necessary, pipes shall be laid in straight lines or with easy curves and true to line and gradient as specified. Laying of pipes shall proceed upgrade of a slope. In the pipes spigot end socket joints, the socket ends shall have face up stream. In the case of pipes with joints to be made with loose collars the collars shall be slipped on before the next pipe is laid.

The Cement Concrete bedding shall be provided below RCC / uPVC pipes as instruction of Engineer in-charge.

When the pipe is laid in a trench in rock hard clay, shale or other hard material the space below the pipe shall be excavated and replaced with an equalizing bed of concrete, sand or compacted earth. In no place shall pipe be laid directly on such hard material.

5.13. TESTING OF JOINTS:

5.13.1. HYDRAULIC TEST:

The pipes shall be subjected to a pressure of at least 2.5 meter head of water at the highest point of the section under test. The test shall be carried out by suitably plugging the low end of the drain and the ends of the connection, if any and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head; or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fix suitably for observation.

Subsidence of the test water may be done to one or the more of the following causes:-

i) Absorption by pipes and joints;
ii) Sweating of pipes or joints;
iii) Leakage at joints or from defective pipes and
iv) Trapped air.

Allowance shall be made for (i) above by adding water until absorption has ceased after which the proper test should commence if any leakage is visible the defective part of the work should be made good. A slight amount of sweating which is uniform may be over looked but excessive sweating from a particular pipe or joint shall be watched for as taken as indicating a defect to be made good.

5.13.2. RECTIFICATION OF FAULTY JOINTS:

Any joint leaking or sweating shall be rectified or embedded into into 150mm layer of cement concrete (1:2:4) 300mm in length and the section retested.

5.14. MANHOLES

Manholes of different types and sizes specified shall be constructed in the sewer line at such places and to such levels and dimensions as shown in the drawing or as directed by the Engineer-in-charge. The size specified shall indicate the inside dimensions (between wall
faces) of the manholes. The branch sewer should deliver sewage in the manhole in direction of main flow and the junction must be made with case so that flow in the main is not impeded.

No drain from house fitting i.e. gully taps or soil pipes etc. to manholes shall normally exceed a length of 6 meter unless it is unavoidable.

At every change of alignment, gradient or diameter of a drain, there shall be a manhole or inspection chamber. Bends and junctions in the drains shall be grouped together in manhole as far as possible. The maximum distance between manholes shall be 45 m for up to 300 mm dia, 75 meter for 350 to 500 mm dia and 90 meter for 600 mm dia and above.

Where the diameter of the drain is increased, the crown of the pipe shall be fixed at the same level and necessary slope given in the invert of the manhole chamber.

Manholes shall be built to the following specifications:-

a) **Bed concrete**:

The manhole shall be built on a bed of cement concrete 1:4:8 (1 cement : 4 coarse sand: 8 graded stone aggregate 40 mm nominal size) The thickness of Bed Concrete shall be 150 mm upto 0.90 meter depth, 200 mm thick for manholes from 0.90 meter to 2.25 meter depth and 30 mm for manholes of above 2.25 meter depth.

b) **Walls**:

The walls of the manholes shall be of brick masonry. The brick masonry shall be with bricks in cement mortar 1:4 (1 cement : 4 coarse sand) of brickwork shall be carefully built in English bond. The jointing face of each brick being well buttered with cement mortar before laying so as to ensure a full joint. The thickness of wall shall not be less than 230mm upto 2.25 meter in depth, 345 mm thick for depth 2.25 to 3.0 meter, 460 mm thick for depths 3.0 m to 5.0 meter and 575 mm thick for 5.0 to 8.0 meter depth. For greater depths and for subsoil water conditions the exact thickness of wall shall be governed by the structural design & site conditions.

c) **Plaster**:

The inside of wall shall be plastered by 12 mm thick with cement mortar 1:3 (1 cement : 3 coarse sand) and finished with a floating coat of neat cement. All angle shall be rounded to 7.5 cm. radius and all rendered internal surfaces shall have impervious finish obtained by using a steel trowel.

Where the saturated soil is met with, also the external surface of the walls of the manhole shall be plastered with 12 mm thick cement plaster 1:3 (1 cement : 3 coarse sand) finished smooth upto 30 cm above the highest sub-soil water level with the approval of the Engineer-in-charge. The plaster shall further be water proofed with addition of approved water proofing compound in a quantity as per manufacturer’s specifications.

d) **Channels and benching**:

Channels shall be semicircular in the bottom half and of diameter equal to the sewer. Above the horizontal diameter, the sides shall be extended vertically to the same level as the crown of the outgoing pipe and the top edge shall be suitably rounded off. The branch channels shall also be similarly constructed with respect to the benching but at their junction with the main channel on appropriate shall suitably rounded off in the direction of flow in the main channel shall be given.

The channels and benching shall be done in cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) rising at a slope of 1 in 6 from the edges of channel. The channels of the bottom of the chamber shall be finished with the floating coat of neat cement.

e) **Foot Rests**:

All manholes deeper than 0.8 m/ UG/OHT/ ETP/STP Tanks shall be provided with orange colour safety foot rest of minimum 6 mm thick plastic encapsulated as per IS : 10910, on 12 mm dia steel bar conforming to IS: 1786, having minimum cross section as 23 mmx25 mm and over all minimum length 263 mm and width as 165 mm with minimum
112 mm space between protruded legs having 2 mm tread on top surface by ribbing or chequering besides necessary and adequate anchoring projections on tail length on 138 mm as per standard drawing and suitable to withstand the bend test and chemical resistance test as per specifications and having manufacturer’s permanent identification mark to be visible even after fixing, including fixing in manholes with 30x20x15 cm cement concrete block 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size) complete as per design.

f) Cover slabs:

These shall be of R.C.C. 1:1.5:3 (1 cement :1.5 coarse sand : 3 graded stone aggregate 20 mm nominal size) 15 cm thick with surface and edge finished fair. Full bearing equal to the width of the wall shall be given to the slab on all sides. The frame of the man hole cover shall be embedded firmly in the R.C.C. slab so that the top of the frame remains flush with the top of the R.C.C. slab. Where the opening of manhole is only 560 mm dia, the MH cover shall be fixed in 150 mm thick PCC (1:2:4).

5.15. TESTING:

Manholes shall be tested by filling with water to a depth not exceeding 1.2 meter as directed by the Engineer-in-charge.

After completion of the work manhole covers shall be sealed by means of thick grease.

5.16. CONNECTION TO EXISTING SEWER:

The connection to an existing sewer shall, as far as possible, be done at the manholes. Where it is unavoidable to make connection between two manholes, the work of breaking into the existing sewer and forming the connection shall be carried out under the supervision of the Administrative Authority.

Breaking of sewer shall be effected by the cautious enlargement of sewer hole and every precaution shall be taken to prevent any material from entering the sewer. No connection shall be formed in such a way so as to constitute a projection into the sewer or to cause any diminutions in its effective size.

5.17. DROP CONNECTIONS:

Where it is uneconomic or impracticable to arrange the connection within 600 mm height above the invert of the manhole, the connection shall be made by constructing a vertical shaft outside the manholes chamber. If the difference in the levels between the incoming drain and the sewer does not exceed 600 mm and there is sufficient room in the manhole, the connection pipe may be directly brought through the manhole wall and the fall accommodated by constructing a ramp in the benching of the manhole.

5.18. PRECAST CONCRETE MANHOLE COVERS & FRAMES

Precast reinforced cement concrete manhole covers intended for use in sewerage, drainage and water works shall generally conform to IS: 12592 - 2002. Detailed specification are as under:

1. GRADES : TYPES & USES

Manhole covers and frames shall be of the following four grades and types:

<table>
<thead>
<tr>
<th>Grades</th>
<th>Grade Designation</th>
<th>Type / shape of cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Duty</td>
<td>LD – 2.5</td>
<td>Rectangular, Square, Circular</td>
</tr>
<tr>
<td>Medium Duty</td>
<td>MD – 10</td>
<td>Rectangular, Circular</td>
</tr>
<tr>
<td>Heavy Duty</td>
<td>HD – 20</td>
<td>Circular-Square, Rectangular</td>
</tr>
<tr>
<td>Extra Heavy Duty</td>
<td>EHD – 35</td>
<td>Circular, Square, Rectangular</td>
</tr>
</tbody>
</table>

2. The different grades and types of manhole covers may be used as follows:

a) LD – 2.5 Rectangular, Square or Circular types:

These are suitable for use within residential and institutional complexes / areas with pedestrian but occasional LMV traffic. These covers may also be used for inspection chambers.
b) **MD – 10:**

These are suitable for use in service lanes / roads, car parking areas etc.

c) **MD – 20:**

Suitable for use in institutional/commercial areas / carriage ways with heavy duty vehicular traffic like buses, trucks, etc. for a wheel load between 50 to 100 KN.

d) **EHD – 35:** Circular, square, or rectangular (scraper manhole) types -

These are suitable for use on carriage way in commercial industrial / port areas / near warehouses / godowns where frequent loading and unloading of trucks / trailers are common, with slow to fast moving vehicular traffic of the types having wheel loads upto 115 KN, irrespective of the location of the manhole chambers.

3. **MATERIALS :**

   (i) **Cement :**

   Cement used for the manufacture of precast concrete manhole covers shall conform to IS : 269 or 455 or 1489 or 6909 or IS : 8041 or IS : 8043 or IS : 8112.

   (ii) **Aggregates :**

   The aggregates used shall be clean and free from deleterious matter and shall conform to the requirements of IS: 383–1970. The aggregates shall be well graded and the nominal maximum size of coarse aggregate shall not exceed 20 mm.

   (iii) **Concrete :**

   The mix proportions of concrete shall be determined by the manufacturer and shall be such as will produce a dense concrete without voids, honey combing etc. (IS : 456) The minimum cement content in the concrete shall be 360 kg/m$^3$ with a maximum water cement ratio of 0.45. Concrete weaker than grade M-30 (design mix) shall not be used. Compaction of concrete shall be done by machine vibration.

   (iv) **Reinforcement :**

   a) The reinforcement steel shall conform to Grade A of IS : 2062 or IS 432 (Part I) or IS : 432 (Part 2) or IS : 1786 as appropriate.

   Reinforcement shall be clean and free from loose mills scale, loose rust, and mud, oil, grease or any other coating which may reduce or destroy the bond between the concrete and steel. A light film of rust may not be regarded as harmful but steel shall not be visibly pitted by rust.

   b) **Fibers steel :** In association with in the main steel bars reinforcement steel fibers of appropriate types and forms may also be used as secondary reinforcement (upto 0.5% by volume).

4. **SHAPES AND DIMENSIONS :**

   The shapes of precast concrete manhole covers shall be square, rectangular or circular with in direction of Engineer Incharge.

5. **LIFTING DEVICE :**

   The minimum diameter of mild steel rod used as lifting device shall be 10 mm for light and 12 mm for medium duty covers and 16 mm for heavy and extra heavy duty covers. The lifting device shall be protected from corrosion by not galvanizing or epoxy coating or any other suitable.

6. **FINISHING AND COATING :**

   To prevent any possible damage from corrosion of steel the underside of the covers shall be treated with anticorrosive paint. The top surface of the covers shall be given a chequered finish.
In order to protect the edges of the covers from possible damage at the time of lifting and handling it is necessary that the manhole covers shall be cast with a protective mild steel sheet of minimum 2.5 mm thickness around the periphery of the covers. Exposed surface of mild steel sheet shall be given suitable treatment with anticorrosive paint or coating.

7. PHYSICAL REQUIREMENTS:
   a) General:
      All units shall be sound and free from cracks and other defects which interface with the proper placing of the unit or impair the strength or performance of the units. Minor chipping at the edge / surface resulting from the customary methods of handling during delivery shall not be deemed for rejecting.
   b) Load test:
      The breaking load of individual units when tested in accordance with the method described in IS : 12592 shall be not less than the values specified in Table below.

<table>
<thead>
<tr>
<th>Grade of cover</th>
<th>Type</th>
<th>Load in Tones</th>
<th>Diameter of Blocks in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>EHD – 35</td>
<td>Circular, Square or Rectangular</td>
<td>35</td>
<td>300</td>
</tr>
<tr>
<td>HD – 20</td>
<td>Circular, Square or Rectangular</td>
<td>20</td>
<td>300</td>
</tr>
<tr>
<td>MD – 10</td>
<td>Circular, or Rectangular</td>
<td>10</td>
<td>300</td>
</tr>
<tr>
<td>LD – 2.5</td>
<td>Rectangular, Square or Circular</td>
<td>2.5</td>
<td>300</td>
</tr>
</tbody>
</table>

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

6. Drilled Bore Wells
   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 tube wells shall be as per IS 2800- 1979 (Part 1 and 2) / CPWD Specification. The Contractor shall ensure the required minimum yield. The Indicative Water sample test report is attached for guidance.

6.1. Selection of Site
   The total water supply to the AIIMS, Guwahati campus is to be met from the water supply through tube wells/bore wells only. No local water supply from the Municipal Bodies is available. The bidder shall assess the total water requirement and propose the location of the tube well / bore wells accordingly for the approval of the Engineer-In-Charge. After conducting the necessary tests, etc., changes, if required, shall be made with the approval of the Engineer-In-Charge.

6.2. 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 analysed and the data shall be preserved carefully and handed over to Engineer-In-Charge. The contractor shall make one drilling time log during the execution of work for the bore well.

6.3. 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 drawdown 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-In-Charge 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.

6.4. 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.

6.5. 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 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 20 parts per million. A record of the hours of working of Air compressor shall be maintained by Engineer-In-Charge which will be signed by the contractor or his authorized representative. 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-In-Charge.

6.6. 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 litres of water.

6.7. Grouting and Sealing

Grouting and sealing of tubewell 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.

6.8. 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 on completion of the tube well:
a) Strata chart of the tube well the different types of soils met with, at different depths.
b) Samples of strata collected, neatly packed and correctly marked in sample bags.
c) 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.
d) Position of every joint in the well assembly.
e) Hours of development done by the compressed air, pump sets or by other means.
f) Pumping water level at the developed discharge.
g) Two copies of test certificates of the water samples results from approved testing agency.
h) Results of development along with levels of static subsoil water and depth of draw for steady discharge.
i) Results of mechanical (sieve) analysis of samples of aquifer materials wherever applicable.
j) Yield analysis and recommendation on the safe pumping yield, pump settings and specifications for suitable pumps etc.
k) Verticality tests results to be recorded in accordance with IS:2800-1979

6.9. Tubewell Data
   i. Yield required minimum 80 KLD per tube well considering 10 hrs. operation per day. (Sand free delivery from bore well)
   ii. Bore - 450 mm dia.(Minimum)
   iii. Approximate depth – 50 metre (Minimum).
   v. Material – MS Class “C” pipes (Heavy Class) as per CPWD specifications
   vi. Verticality – True verticality as per IS – 2800-1979
   vii. Packing – Pea Gravel
   viii. Developing – Minimum 100 Hrs or till sand free discharge is obtained.
   ix. Water for drilling – Contractor shall make his own arrangement for water required for drilling purposes as well for development purposes.
   x. 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.

6.10. All the casings shall be of ERW steel quality confirming to IS specifications and carry manufacturer’s certificate. The pipes shall have a wall thickness of not less than 7 mm or as per IS 1239. The slotted pipes must 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 in accordance with the norms stipulated in IS 2800.

6.11. 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.

7. Water Supply Pumping System & Allied services

7.1. Scope of work

The scope of work 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 DBR and/or shown on the plumbing drawings and described in the scope of work.

7.2. The System

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.

a. Sources of supply

The external water supply shall be met from Bore wells.

b. Partially 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 raw water tanks

ii. Raw Water Tank to hold the tube well as well as CWS Supply water will be made to:

1. A set of pumps will be connected to and water filter and chlorination system and the filtered water stored in the Treated Water Tanks (in three compartments. All piping and connections for this system are a part of this contract, if required.

2. Domestic Water Pumping Systems

iii. 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.

2. 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.

3. 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 a 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 & motorized butterfly valve

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 motorized butterfly valve complete with high and low level control switches to control the valve. The level controllers shall be installed in overhead tanks. The level switch will close the valve when water level is high (Top Water Level) in over head tank and open the valve when over head water tank level is low (30% of storage capacity). The system should be complete in all respects with accessories, 220 V AC / 24 V DC, IP67 electrical water level control unit, copper control wiring in whether proof casing etc 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 Engineer-In-Charge. 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.

4. Pressure filters for Water Supply System, if required.

a. Specification shall apply for water filtration system

i. Pressure filters shall be manufactured with factory made bobbin wound polyester fibre glass multilayer filters fitted with internal GI distribution pipe with polypropylene diffusers on top, collector pipes and arms, inlet and outlet header vertical water pressure dished ends complete with initial charge of filter media, G.I. face piping, accessories testing and commissioning complete, Working Pressure 2.4 kg/cm² (Test pressure 3.75 kg/cm²). Along with bfv & nrv & gauge, prv etc.

ii. Each vessel will be provided with suitable pressure tight manhole cover appropriately located for inspection and repairs.

iii. The diameter and height of each vessel shall be as per the design requirement and as per site conditions.

b. Multi-Port Valves

i. Each vessel will be provided with multi-port valves to operate and regulate the normal flow, backwash and rinsing, rapid washing on the face piping.

ii. Provide suitable sampling cocks to draw water samples for raw water and treated water.

c. Face Piping
i. Each vessel shall be provided with G.I heavy class face piping from the inlet to the outlet. Face piping & fitting shall be G.I heavy class and treaded, weld and flanged joints

ii. All valves shall be butterfly valves as specified in the piping section over 50 mm dia. and for pipe dia. below 50 mm dia. shall be provided with ball valves.

d. Water Filtration Plant (For Domestic Water)

i. Design parameters for the proposed filter shall be as follows:

1. Filter media: - Graded aggregate of required size selected coarse and fine silica sand as per latest water treatment practice. Aggregate and sand to be acid washed and having purity of 99.9%.

2. Depth of filter media:- Approx. 750-900 mm deep (as per manufacturer’s design)

3. Back washing :- By air scouring through air blower (approx. 5.1 lpm/m² of filter surface area and water supply from raw water pumps by reverse flow)

4. Output Water Quality for Domestic Filters: To conform to IS 10500 for the relevant design criteria

e. Chemical Dosing Pumps

i. Pump applications

1. Chlorination of raw water from tube wells,

ii. Dosing system comprising of an electronic metering pump with, 100 lit capacity uPVC/HDPE solution tank with level gauge and lid on top.

iii. Electronic driven metering pumps with mechanically actuated diaphragm with oil lubricated gear mechanism. The output of the pump should be adjustable for operation from 10-100%. Pump construction shall be corrosion resistant polypropylene or similar material. Pump electrical circuit shall be interlocked with the main raw water /pool recirculation pumps so that they operate only when the pumps are operating.

f. Air Blower for Back Washing

i. Low pressure air blower with TEFC electrical motor, belt driven or direct drive, all mounted on a common structural based plate with oil and water separator.

ii. Air blowers will be used for back washing operations. The air blower shall be designed for operation of one filter at a time. Blowers will be designed for air flow of approx. 5.1 lpm/m² air capacity at 0.5 kg/cm² pressure. (This may be modified to suit manufacturer’s requirement for filters offered.)

iii. The electrical switchgear shall be included in the respective MCC panel of the system

8. Pipes & 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 D.I / G.I. / CPVC pipes (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 D.I/G.I. tubes to IS 3589. If black pipes are available they shall be galvanized before use.
c. Fittings for D.I./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 galvanized. 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. D.I./G.I. Pipes (Screwed joints)

Pipe shall be provided with metal to metal threaded joints/push on joints etc. 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

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 D.I/G.I. nuts and bolts, 3 mm insertion rubber gasket complete.

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.

9. The detailed specifications for all Plant rooms have been mentioned in individual subheads.

10. Specifications for Electrical Installation

1. Electrical Control Panels

a. General

i. All medium voltage switchboards shall be suitable for operation at three phase/three phase 4 wire, 415 volt, 50 Hz, neutral grounded at transformer system with a short circuit level withstand of 31 MVA at 415 volts.

ii. The Switch Boards shall comply with the latest edition with up to date amendments of relevant Indian Standards and Indian Electricity Rules and Regulations.

b. Switch Board Configuration

i. The Switch Board shall be configured with Air Circuit Breakers, MCCB’s, and other equipments.

ii. The MCCB’s shall be arranged in multi-tier formation whereas the Air Circuit Breakers shall be arranged in Single or Double tier formation only to facilitate operation and maintenance.

iii. The Switch Boards shall be of adequate size with a provision of 25% spare space to accommodate possible future additional switch gear.

c. Equipment Specifications

All equipment used to configure the Switch Board shall comply to the relevant Standards and Codes of the Bureau of Indian Standards and to the detailed technical Specifications as included in this tender document.

d. Constructional Features

i. The Switch Boards shall be metal enclosed, sheet steel cubicle pattern, extensible, dead front, floor mounting type and suitable for indoor mounting.
ii. The Switch Boards shall be totally enclosed, completely dust and vermin proof. Synthetic rubber gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust and vermin proof to provide a degree of protection of IP 54 as specified. All doors and covers shall also be fully gasketed with synthetic rubber and shall be lockable.

iii. The Switch Board shall be fabricated with CRCA Sheet Steel of thickness not less than 2.0 mm and shall be folded and braced as necessary to provide a rigid support for all components. The doors and covers shall be constructed from CRCA sheet steel of thickness not less than 1.6 mm. Joints of any kind in sheet metal shall be seam welded and all welding slag ground off and welding pits wiped smooth with plumber metal.

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

v. Fixing screws shall enter holes tapped into an adequate thickness of metal or provided with hank nuts. Self-threading screws shall not be used in the construction of the Switch Boards.

e. **Switchboard Dimensional Limitations**

i. A base channel 100 mm x 50 mm x 6 mm thick shall be provided at the bottom.

ii. A minimum of 200 mm blank space between the floor of switch board and bottom most units shall be provided.

iii. The overall height of the Switch Board shall be limited to 2300 mm.

iv. The height of the operating handle, push buttons etc shall be restricted between 300 mm and 2000 mm from finished floor level.

f. **Switch Board Compartmentalisation**

i. The Switch Board shall be divided into distinct separate compartments comprising.

ii. A completely enclosed ventilated dust and vermin proof bus bar compartment for the horizontal and vertical bus bars.

iii. Each circuit breaker and MCCB shall be housed in separate compartments enclosed on all sides.

iv. Sheet steel hinged lockable doors for each separate compartment shall be provided and duly interlocked with the breaker in "on" and "off" position.

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

vi. A horizontal wire way with screwed cover shall be provided at the top to take interconnecting control wiring between vertical sections.

vii. Separate cable compartments running the height of the Switch Board in the case of front access Boards shall be provided for incoming and outgoing cables.

viii. Cable compartments shall be of adequate size for easy termination of all incoming and outgoing cables entering from top.

ix. Adequate and proper support shall be provided in cable compartments to support cables.

g. **Switch Board Bus Bars**

i. The Bus Bar and interconnections shall be of electrolytic Copper/Aluminium and of rectangular cross sections suitable for full load current for phase bus bars and half rated current for neutral bus bar. The maximum current density for copper shall be 1.6 amps per sq. mm. and for Aluminium shall be 1 amp per Sq. mm. and
suitable to withstand the stresses of a 31 MVA fault level or at 415 volts for 1 second.

ii. The bus bars and interconnections shall be insulated with insulation tape/ fibre glass.

iii. The bus bars shall be extensible on either side of the Switch Board.

iv. The bus bars shall be supported on non-breakable, non-hygroscopic insulated supports at regular intervals, to withstand the forces arising from a fault level of 31 MVA at 415 volts for 1 second.

v. All bus bars shall be colour coded.

vi. All bus bar connections in Switch Boards shall be bolted with brass bolts and nuts. Additional cross section of bus bars shall be provided wherever holes are drilled in the bus bars.

h. Switch Board Interconnections

i. All connections between the bus bars/Breakers/cable terminations shall be through solid tinned copper strips of adequate size to carry full rated current and PVC/fibre glass insulated.

ii. For unit ratings up to 100 amps PVC insulated copper conductor wires of adequate size to carry full load current shall be used. The terminations of all such interconnections shall be crimped and aluminium lugs shall be used.

i. Draw out Features

Air Circuit Breakers shall be provided in fully draw out cubicles. These cubicles shall be such that draw out is possible without disconnection of the wires and cables. The power and control circuits shall have self-aligning and self-isolating contacts. The fixed and moving contacts shall be easily accessible for operation and maintenance. Mechanical interlocks shall be provided on the draw out cubicles to ensure safety and compliance to relevant Standards. The MCCB’s shall be provided in fixed type cubicles.

j. Instrument Accommodation

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

ii. For MCCB’s instruments and indicating lamps can be provided on the compartment doors.

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

k. Wiring

All wiring for relays and meters shall be with PVC insulated copper conductor wires. The wiring shall be coded and labelled with approved ferrules for identification. The minimum size of copper conductor control wires shall be 1.5 sq. mm.

l. Cable Terminations

i. Knockout holes of appropriate size and number shall be provided in the Switch Board in conformity with the location of incoming and outgoing conduits/cables.

ii. The cable terminations of the Circuit Breakers shall be brought out to terminal cable sockets suitably located at the rear / top of the panel.

iii. The cable terminations for the MCCB’s shall be brought out to the rear in the case of rear access switchboards or in the cable compartment in the case of front access Switch Boards.
iv. The Switch Boards shall be complete with tinned brass cable sockets, tinned brass compression glands, gland plates, supporting clamps and brackets etc for termination of 1100 volt grade aluminium conductor PVC/PVCA cables.

m. Space Heaters

The Switch Board shall have in each panel thermostatically controlled space heaters with a controlling 15 amp 230 volt switch socket outlet to eliminate condensation.

n. Ventilation Fans

The Switch Board shall be provided with panel mounting type ventilation fans in each panel with switchgear rated for 2500 amp and above. The fan shall be interlocked with switchgear operation.

o. Earthing

A main earth bar of G.I./copper as required shall be provided throughout the full length of the Switch Board with a provision to make connections to the can be tap from main earthing.

p. Sheet Steel Treatment and Painting

i. Sheet Steel materials used in the construction of these units should have undergone a rigorous rust proofing process comprising of alkaline degreasing, descaling in dilute sulphuric acid and a recognised phosphating process. The steel work shall then receive two coats of oxide filler primer before final painting. Castings shall be scrupulously cleaned and fettled before receiving a similar oxide primer coat.

ii. All sheet steel shall after metal treatment be spray or powder painted with two coats of shade 692 to IS 5 on the outside and white on the inside. Each coat of paint shall be properly stoved and the paint thickness shall not be less than 50 microns.

q. Name Plates And Labels

Suitable engraved white on black name plates and identification labels of metal for all Switch Boards and Circuits shall be provided. These shall indicate the feeder number and feeder designation.

2. Testing

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

3. Testing at Site

a. Pre-commissioning tests as required and as per manufacturers recommendations shall be carried out on each switchboard at site before energizing the switchboards including but not restricted to the following.

i. Physical checking of the switchboards including checking alignment of panels, interconnection of Bus bars, tightness of bolts/connections and evidence of damage/cracks in any components.

ii. Physical checking and inspections of Inter panel wiring

iii. Checking free movement of ACBs/MCCBs/SFUs

iv. Checking of operation of breakers

v. Insulation tests of bus bar supports and control wiring etc. with 1.1 kV meger.

vi. Primary & secondary injection tests of relays and CTs.

vii. Checking of Interlocking function.
4. Cables

i. Medium Voltage Cables

a. Medium voltage cables shall be aluminium conductor PVC insulated, PVC sheathed armoured conforming to IS 1554. Cables shall be rated for a 1100 Volts. The conductor of cables from 16 Sq. mm. to 50 mm² shall be stranded. Sector shaped stranded conductors shall be used for cables of 50 mm² and above. Conductors shall be made of electrical purity aluminium 3/4 H or H temper. Conductors shall be insulated with high quality PVC base compound. A common covering (bedding) shall be applied over the laid up cores by extruded sheath of unvulcanised compound. Armouring shall be applied over outer sheath of PVC sheathing. The outer sheath shall bear the manufacturer’s name and trade mark at every meter length. Cores shall be provided with following colour scheme of PVC insulation.

| 1 Core | Red/Black/Yellow/Blue |
| 2 Cores | Red and Black |
| 3 Cores | Red, Yellow and Blue |
| 3.5/4 Cores | Red, Yellow, Blue and Black |

b. Current ratings shall be based on the following conditions.

i. Maximum conductor temperature  70° C
ii. Ambient air temperature  45° C
iii. Ground temperature  30° C
iv. Depth of laying  1000 mm

c. Short circuit rating of cables shall be as specified in IS 1554 Part-I.
d. Cables have been selected considering conditions of maximum connected loads, ambient temperature, grouping of cables and allowable voltage drop. However, the contractor shall recheck the sizes before cables are fixed and connected to service.
e. M.V. cables shall be PVC insulated aluminium/copper conductor and armoured cables conforming to IS Codes. Cables shall be armoured and suitable for laying in trenches, duct and on cable trays as required. Control cables and indicating panel cables shall be multi core PVC insulated copper conductor and un armoured cables.

ii. On Trays/Walls

a. Wherever so specified, cables shall be laid along walls/ceiling or on cable trays. Cable shall be secured in position and dressed properly by means of suitable clamps, hooks, saddles etc. such that the minimum clear spacing between cables is diameter of the cable. Clamping of cables shall be at minimum intervals as below.

<table>
<thead>
<tr>
<th>Type of Cable</th>
<th>Size</th>
<th>Clamping by</th>
<th>Fixing Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>MV</td>
<td>Up to and including 25 sq mm</td>
<td>Saddles 1 mm thick</td>
<td>45 cms</td>
</tr>
<tr>
<td>MV &amp; HV</td>
<td>35 sq mm to 120 sq mm</td>
<td>Clamps 3 mm thick 25 mm wide</td>
<td>60 cms</td>
</tr>
<tr>
<td>MV &amp; HV</td>
<td>150 sq mm and above</td>
<td>Clamps 3 mm thick 40 mm wide</td>
<td>60 cms</td>
</tr>
</tbody>
</table>

Note: The fixing intervals specified apply to straight runs. In the case of bends, additional clamping shall be provided at 30 cm from the centre of the bend on both sides.

b. Cable trays
i. Cable trays shall be fabricated from sheet GI of required thickness. Cable trays, of sizes as per DBR/drawings shall be of perforated doubled bend and shall be complete with tees, elbows, risers, and all necessary hardware.

ii. Trays shall have suitable strength and rigidity to provide proper support for all the contained cables. Trays shall not have sharp edges, burrs or projections injurious to cable insulation. Trays shall include fittings for changes in direction and elevation. Cable trays and accessories shall be painted with two coats of red oxide zinc chromate primer after proper surface preparation and two finishing coats of synthetic enamel paint of approved make. Cable trays shall have side rails or equivalent structural members.

iii. Cable trays shall be mounted on support structure as specified by means of specified size of threaded rods and suitable fasteners. Spacing of the support structure shall be such that the cable trays shall remain perfectly horizontal without buckling when fully loaded with cable runs. The support structure shall be suspended from ceiling slab or grouted to walls in an approved manner. Width of the horizontal arms of the support structure shall be same as the tray width plus length required for threading/bolting/welding to the vertical supports. The length of vertical supporting members for horizontal tray runs shall be to suit the number of tray tiers required. Cable trays shall be bolted/welded to the support structure. Minimum clearance between the top most tray tier and the ceiling shall be 300 mm. Trays shall be erected properly to present a neat and clean appearance. Trays shall be installed as a complete system. The entire cable tray system shall be rigid. Each run of cable tray shall be completed before laying of cables. Cable trays shall be erected so as to be exposed and accessible. Cables shall be fixed to the tray by clamps fabricated from minimum 3 mm thick GI sheets. The cables shall be dressed properly so as to provide minimum one cable diameter clearance between adjacent cables and from tray ends. Cable trays shall be earthed by 2 runs of 25 mm x 3 mm GI strips throughout their lengths.

5. LAYING OF CABLES

Cables shall be so laid that the maximum bending radius is 12 times the overall diameter of the cable for medium voltage cables. Cables shall be laid in masonry trenches, directly on walls/cable trays, directly buried in ground or in pipes/ducts as elaborated below. Cables of different voltages and also power and control cables shall be laid in different trenches with adequate separation. Wherever available space is restricted such that this requirement cannot be met, medium voltage cables shall be laid above HT cables. Where more than one cable is laid side by side, cable marker tags of approved type inscribed with cable identification details shall be permanently attached to cables at entry points to the building, at specified intervals for cables laid direct in grounds and in locations like manholes, pull pits etc.

6. Drawings

Shop drawings for control panels and wiring of equipment showing the route of conduit cable shall be submitted by the contractor for approval of Engineer-in-charge before starting the fabrication of panel and starting the work. On completion, all details like location of panels, switches, junction/pull boxes and cables route etc. shall be furnished by the contractor.

9.0 Commissioning and Guarantees

a) Scope of work

The work under this section shall consist of pre-commissioning, commissioning, testing and providing guarantees for all equipment, appliances and accessories supplied and installed by the contractor under this contract.

b) General requirements:
a. Contractor shall provide all tools, equipment, metering and testing devices 
required for the purpose.

b. On award of work, contractor shall submit a detailed proposal giving 
methods of testing and gauging the performance of the equipment to be 
supplied and installed under this contract.

c) Pre commissioning

a. On completion of the installation of all pumps, piping, valves, pipe 
connections, electrical wiring, motor control panels and water level controlling devices the 
contractor shall proceed as follows:-

i. Testing of M.C.C

ii. Tests to be carried out for motor control centres shall be:

iii. Insulation resistance test with 500 volt megger, before and after high 
voltage test, on all power and control wiring.

iv. High voltage test sat 2000 volts A.C. for one minute on all power and 
control wiring.

v. Low voltage continuity test (6 volts) on power wiring of each feeder, 
between bus bars and the outgoing terminals with switches and 
contactors in closed position.

vi. Low Voltage continuity test (6 volts) on all control wiring.

vii. Operation test for all feeders with only control supply made 'on' to 
ensure correctness of control wiring, operation of the various equipment 
used such as push buttons, protective devices, indicating lamps and 
relays etc. All contactors shall be checked and there shall be no 
chattering.

viii. Earth continuity test with voltage not exceeding 6 volts between various 
non-current carrying metallic parts of equipment, steel work etc. And the 
earth bus provided in the MCC.

ix. Operation of all instruments and meters provided on the MCC.

b. Pipe work

i. Check all clamps, supports and hangers provided for the pipes.

ii. Fill up pipes with water and apply hydrostatic pressure to the 
system as given in the relevant Part of the specifications. If any 
leakage is found, rectify the same and retest the pipes.

iii. Check all face piping and valves

iv. check air blower connections

d) Commissioning & testing

a. All pumping sets :-Start the duty pump on manual controls, check its operation and 
than test run on auto controls. Change over the duty pump and test it in the same 
manner as the first pump.

b. Test runs the entire system to ensure satisfactory performance.

e) Handing Over

a. All commissioning and testing shall be done by the contactor to the complete 
satisfaction of the Engineer-In-Charge and the job handed over to the 
Engineer-In-Charge or his authorized representative.

b. Contractor shall also hand over, to the Engineer-In-Charge, all maintenance & 
operation manuals, 4 sets of As Built drawings and all other items as per the terms of 
the contract with soft copy.

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

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

c. The warranty shall be valid for a period of one year from the after getting virtual completion certificate.

d. 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.

e. The warranty shall include replacement of any equipment found to have capacity lesser that the rated capacity as accepted in the contract. The replacement equipment shall be approved by the Engineer-In-Charge.

f. The contractor shall separately submit with this offer his charges per month for operation of mechanical equipment(s) after commissioning and handing over.

11. I.S. Codes

Following codes and Indian standards shall be applicable as amended up to date-

**A. Electrical equipment**

1. Marking & arrangement for switch gear bus bars, main connections and auxiliary wiring- I.S. 375

2. Direct acting electrical indicating instruments - I.S. 1248

3. Metal enclosed switch gear and control gear - I.S. 3427

4. A.C. Contactors of voltage not exceeding 1000 volts. - I.S. 2959

5. A.C. Motor starters of voltage not exceeding 1000 volts. - I.S. 1822

6. Air breaks isolation for voltages not exceeding 1000 volts - I.S. 2607

7. Heavy duty air break switches and composite unit of air break switches and fuses for voltage not exceeding 1000 volts. - I.S. 4047

8. PVC insulated cables (for voltage Up to 1100 volts with copper/ aluminium conductors)(Section I & II)- I.S. 694

9. Normal duty air break switches and composite units of air break switches and fuses for voltage not exceeding 1000 volts. - I.S. 4064


11. Pumps & motors

  a. Centrifugal pumps - I.S. 1520

  b. Electrical Motors - I.S. 7538

12. Pipes

  a. G.I. Pipes - I.S. 1239

13. Valves

  a. Butterfly Valves - IS 23339/13095

  b. Slim Type NRV - I.S. 7312

  c. Sluice valve - I.S. 780

14. Vibration Eliminator

15. Water Shock Absorbers

12. Technical Information for Water Supply & Drainage Pumps to be furnished by Bidder:

i. **Pumps**
   a. Make
   b. Model
   c. Pump Discharge - Max/Min
   d. Pump Head Min/Max,
   e. Impeller Material
   f. Motor HP
      (Specify make, class of insulation & rated voltage ± %)
   g. Shaft Seal Type & make
   h. Type of Coupling
   i. Efficiency of Pump
   j. Type of Bearings
   k. RPM

ii. **Pressure Tanks ( Where specified)**
   a. Make
   b. Material of Construction
   c. Internal finish
   d. External finish
   e. Air balloon/ diaphragm
   f. specifications

iii. **Submersible pumps- Plant Room- Sewage**
   a. Make
   b. Model No.
   c. Pump discharge lpm - max / min
   d. Pump head min/max,
   e. Impeller material
   f. Motor HP (Specify make, class of insulation & rated voltage ± %)
   g. Shaft seal Type & make
   h. Type of coupling
   i. Efficiency of pump
   j. Type of bearings
   k. RPM

iv. **Motor Control Centres ( Give detail on separate sheets if required )**
   a. Make
   b. Type (floor/wall mounted)
   c. Make of switch gear
   d. Make of meters
   e. Make of accessories
f. Confirm that all switch gear starters match the capacities of pumps offered.

v. **Power & control cables**
   a. Make

vi. **Electronic Level controllers**
   a. Make
   b. Model No.

vii. **Electronic High Water Alarm**
   a. Make
   b. Model No.

viii. **Electronic Level Indicator**
   a. Make
   b. Model

ix. **Pipes /CPVC**
   a. Make offered
      i. Heavy Class 150 mm dia. & below
      ii. Heavy Class 200 mm dia. & above
   b. CPVC Pipe

x. **Butterfly Valves**
   a. Make
   b. Material
   c. Test pressure

xi. **NRV Slim Type**
   a. Make
   b. Material
   c. Test pressure

xii. **Vibration eliminators**
   a. Make
   b. Material
   c. Test pressure

xiii. **Pressure**
   a. Working pressure
   b. Test pressure
   c. Filtration/holding Capacity
   d. Inlet/outlet sizes

xiv. **Painting/coating**
   a. Inside
   b. Outside
xv. **Equipment- Air Blower Chlorinato**

   a. Make
   b. Model
   c. Pump Discharge - Max/Min
   d. Pump Head - Min/Max,
   e. Impeller Material
   f. Motor HP (Specify make, class of insulation & rated voltage ± %)
   g. Shaft Seal
   h. Type of Coupling
   i. Efficiency of Pump
   j. Type of Bearings
   k. Speed of Pumps

xvi. **Motor control centres**

   a. Type (floor/wall mounted)
   b. Make of switch gear
   c. Make of panel meters
   d. Confirm that all switch gear starters are of capacities for pumps offered.

xvii. Pipe fitting scheduled.

xviii. P.P. Pipe

xix. RCC Pipe.

xx. uPVC Pipe.

xxi. cPVC Pipe.

xxii. Insulation Material

xxiii. Flow Meter.

xxiv. PRV

xxv. Hydro-pneumatic Pump.

xxvi. Water meter.
CHAPTER D
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 in DBR, Tender Drawings.

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
   a. 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 he 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.
   b. SOIL: The soil itself shall be ensured to satisfaction of Engineer to be a good, fibrous loam, rich in humus.
   c. SOWING THE GRASS ROOTS :
      i. Grass roots (Cynodon dactylon 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.
   d. EXECUTION :
      i. Small roots shall be debbled about 15 cms 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.
e. 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 announce 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 \( \frac{1}{2} \) to \( \frac{3}{4} \) 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.

f. 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.

g. 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.

h. 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.

i. WATERING: Water shall be applied daily during dry weather. Watering whenever done should be thorough and should wet the soil at least upto a depth of 20 cms to eliminate air pockets and settle the soil.

j. WEEDING: Prior to regular mowing the contractor shall carefully remove rank and unsightly weeds.

4. MAINTENANCE: The contractor shall maintain all planted area within the landscape contract boundaries until the period of one year after the completion of project. 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 area neat in appearance.

5. PRUNING & REPAIRS: Upon completion of planting work on the landscape 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. DIGGING HOLES FOR PLANTING TREES

In ordinary soil, refilling earth after mixing with manure and Watering.
Holes of circular shape in ordinary soil shall be excavated and excavated soil broken to clods of size not exceeding 75 mm in any direction, shall be stacked outside the hole, stones, brick bats, unsuitable earth and other rubbish, all roots and other undesirable growth met with during excavation shall be separated out and unserviceable material removed from the site as directed. Useful material, if any, shall be stacked properly and separately. Good earth in quantities as required to replace such discarded stuff shall be brought and stacked at site by the contractor. The tree holes shall be manured with powdered Neem/castor oil cake at the specified rate along with farm yard manure over sludge shall be uniformly mixed with the excavated soil after the manure has been broken down to powder, (size of particle not be exceeded 6 mm in any direction) in the specified proportion, the mixture shall be filled in to the hole up to the level of adjoining ground and then profusely watered and enable the soil to subside the refilled soil shall then be dressed evenly with its surface about 50 to 75 mm below the adjoining ground level or as directed by the Engineer-in-charge.

7. FLOODING THE GROUND WITH WATER AND MAKING KIARIES

The water for flooding shall be of soft water and free from chemical and good for growing the trees and shrubs etc. Before flooding the kiaries shall be made in required size and shape as per directions of Officer-in-charge. After uprooting weeds from the trenched area and uprooting vegetation, kiaries shall be dismantled.

8. SPECIFICATIONS OF PLANTS

The plants should be as per following specification.

i. The plants should be full of fresh and healthy foliage.

ii. The plants should be free from insect, pest and disease.

iii. Plant should be healthy and vigorous growth

iv. The height of the plants will be measured from top of the pots.

v. The plants should be well settled and should not be newly shifted.

vi. The plants should be true to the variety and named Variety should be tagged.

vii. Moss stick used should be made on plastic pipe.

viii. Moss stick should be straight and properly fixed in the pot.

ix. The rejected plants materials should be removed from the site immediately.

x. Moss stick should be covered with the plants in case of plants supplied with moss stick.

xi. The Plant should be well established and good spread.

xii. Good earth and manure used for filling the pot/poly bag free from any inert material and mixed to proper ratio.

xiii. Pot/ Poly bag used for filling the plants should be proper size good quality not damaged.

xiv. There should be proper drainage in pots for plants.

xv. The flowering plants should also have proper flowering and should be true to the variety.

xvi. All plant should have the tendency of growth and should not be stunted type.

xvii. There should be no stagnation of water in the pots.

9. 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 drying 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 abeled. If for any reason the surface of the roots becomes dry the roots should be thoroughly soaked before planting.

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

11. COMPLETION: On completion the ground should be formed over and left tidy.
## List of Approved Makes of Materials-Civil & Plumbing

<table>
<thead>
<tr>
<th>S.No</th>
<th>Details of equipment/ material</th>
<th>Make/Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. CIVIL WORKS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Acoustical Panelling</td>
<td>ECOTONE/ Armstrong/ Anutone</td>
</tr>
<tr>
<td>2.</td>
<td>Adhesive for Ceramic tiles</td>
<td>Cico / Pidilite / Bal Endura / Laticrete/ Fosroc</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>Aludcor / Alucobond /Alstone</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/ Sections</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 Fastner/Dash Fastner</td>
<td>Hilti / Fischer /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>Back up rod</td>
<td>Supreme Industry or equivalent</td>
</tr>
<tr>
<td>12.</td>
<td>Batch Mix Concrete (BMC) / Ready Mix Concrete (RMC)</td>
<td>The contractor to install his own computerized batching plant of suitable capacity and arrange for Transit Mixers, pumps etc. as per approval of Engineer – In-Charge. Or The RMC shall be procured from the source as approved by Engineer – in Charge. RMC Producing plants of the main Cement producers shall be preferred</td>
</tr>
<tr>
<td>13.</td>
<td>Bitumen</td>
<td>Indian Oil, Hindustan Petoleum, Bharat Petroleum</td>
</tr>
<tr>
<td>15.</td>
<td>Cement: White</td>
<td>Birla White / JK</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>Saint Gobain (SG) / Asahi India Safety Glass Ltd /Modiguard</td>
</tr>
<tr>
<td>18.</td>
<td>Concrete Additive</td>
<td>Pidilite / Fosroc / Fairmate / MC Bauchemie/Sika/Cico/</td>
</tr>
<tr>
<td>19.</td>
<td>Cover /Spacer Block</td>
<td>Conbextra as manufactured by M/s Fosroc Chemicals India Ltd. or equivalent</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>20.</td>
<td>Curtain Rod/ Drapery Rod/ Venetian Blinds</td>
<td>Vista work / Mac Décor or equivalent</td>
</tr>
<tr>
<td>21.</td>
<td>Crash Guard/ Corner Guard</td>
<td>MDD/TSI/LSR/Radius</td>
</tr>
<tr>
<td>22.</td>
<td>Door closer / Floor spring</td>
<td>Hardwyn/Godrej/ Dorma/Doorking/Everite</td>
</tr>
<tr>
<td>23.</td>
<td>Door Locks</td>
<td>Godrej / Harrison / Dorma/Link</td>
</tr>
<tr>
<td>24.</td>
<td>Door Seal – Woolpile Weather Strip</td>
<td>Anand Reddiplex,/ Enviroseal</td>
</tr>
<tr>
<td>25.</td>
<td>Door Shutters- Flush</td>
<td>Duro / Greenply/Archidply / Century / Merino</td>
</tr>
<tr>
<td>27.</td>
<td>Epoxy Flooring</td>
<td>Fosroc/ Dr. Beck/ Flamaflor</td>
</tr>
<tr>
<td>28.</td>
<td>Extruded Polystyrene Board</td>
<td>Styrofoam by DOW Chemicals / Insuiboard by</td>
</tr>
<tr>
<td>29.</td>
<td>False Ceiling - Calcium Silicate Boards &amp; Tiles</td>
<td>India Gypsum/ Armstrong / Hilux / Saint</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gobain (Gyproc)/Aerolite</td>
</tr>
<tr>
<td>30.</td>
<td>False Ceiling - Metal</td>
<td>Armstrong / Hunter-Douglas / USG-Boral/</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Saint Gobain/ Unimet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Saint Gobain (Gyproc)</td>
</tr>
<tr>
<td>32.</td>
<td>Fire Rated Doors &amp; Frames</td>
<td>Navair / Shakti-Hormann / Pacific/Promat</td>
</tr>
<tr>
<td>33.</td>
<td>Fire Rated Glass</td>
<td>Asahi India Safety Glass Ltd./ Saint Gobain/</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pillington, Schott, Pyroguard, Glaverbel</td>
</tr>
<tr>
<td>34.</td>
<td>Fire Retardant Paint</td>
<td>Viper FRS 881/ Nullfire/ Berger</td>
</tr>
<tr>
<td>35.</td>
<td>Fire Seal</td>
<td>Sealz, Alstroflam/ Abacus</td>
</tr>
<tr>
<td>36.</td>
<td>Fire: Door Closures, Mortice Dead locks</td>
<td>Becker Fire Solution/ Inersoll Rand/ Dorma/Godrej /</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Geze/ Hafele</td>
</tr>
<tr>
<td>37.</td>
<td>Fire: D-Type Pull Handles</td>
<td>Becker Fire Solution/ Dorma/ Hardwyn /Godrej</td>
</tr>
<tr>
<td>38.</td>
<td>Fire: Hinges,</td>
<td>Becker Fire Solution/ Inersoll Rand/ Dorma/Godrej /</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Geze/ Hafele</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dorma PHA Series/ D-line/Godrej</td>
</tr>
<tr>
<td>40.</td>
<td>Fire: Sealant</td>
<td>Birla/ 3M/ Hilti</td>
</tr>
<tr>
<td>41.</td>
<td>Fire: Tower Bolts</td>
<td>Suzu/ Nulite, Dorset/ Dorma/Godrej</td>
</tr>
<tr>
<td>42.</td>
<td>Floor Hardener</td>
<td>Pidilite / SIKA / Fairmate / BASF</td>
</tr>
<tr>
<td>43.</td>
<td>Glass : Float &amp; Mirror</td>
<td>Modiguard / Atul / Saint Gobain/ Asahi India Safety</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Glass Ltd / Modi Glass</td>
</tr>
<tr>
<td>44.</td>
<td>Glass for Aluminum Doors/ Windows/ Structural</td>
<td>Modiguard / Saint Gobain / Pilkington/ Asahi India</td>
</tr>
<tr>
<td></td>
<td>Glazing</td>
<td>Safety Glass Ltd./ Modiglass</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>45.</td>
<td>Glass Wool / Insulation Boards/Puf Insulated Roofing</td>
<td>Rockwool / UP Twiga / Lloyd Insulation /Pidilite</td>
</tr>
<tr>
<td>46.</td>
<td>GRC Jali</td>
<td>Unistone/ Kuber Fibrostone/Everest Composites/ Birla white</td>
</tr>
<tr>
<td>47.</td>
<td>Grout: Non-Shrink</td>
<td>Fosroc / Sikka/Pidilite or equivalent</td>
</tr>
<tr>
<td>48.</td>
<td>Grouting Compound</td>
<td>Bal Endura/ Pidilite/ Laticrete/ Unility</td>
</tr>
<tr>
<td>49.</td>
<td>Gypsum Board / Gypsum False Ceiling/ Gypsum Partitions</td>
<td>USG-Boral Gypsum / India Gypsum / Lafarge / Saint Gobain (Gyproc)</td>
</tr>
<tr>
<td>50.</td>
<td>Laminates/ Veneers</td>
<td>Century/Archidply/Greenlam/Formica/Sunmica / Merino</td>
</tr>
<tr>
<td>51.</td>
<td>Lead Lined Door</td>
<td>REBBON, Kutty’s, AHALDA</td>
</tr>
<tr>
<td>52.</td>
<td>Modular Grab bars and Disabled Hardware</td>
<td>Dorma / D-line</td>
</tr>
<tr>
<td>53.</td>
<td>Modular SS Railing System</td>
<td>Metallica India / D – Line International Denmark / Mobel Hardware</td>
</tr>
<tr>
<td>54.</td>
<td>Neutron Shielded Door</td>
<td>Ray-Ban Engg corp/A-Fabco In/A7L shielding INC/Accurate Radiation Shielding</td>
</tr>
<tr>
<td>55.</td>
<td>Night Latch</td>
<td>Godrej / Dorma/ Ozone/Harrison/Link</td>
</tr>
<tr>
<td>56.</td>
<td>OT: Anti-Fungal paint</td>
<td>Sikka by Liquid Plastic/ Viesmann/ SSK/ TRILUX</td>
</tr>
<tr>
<td>57.</td>
<td>OT: Conductive Tile Flooring: ESD-Control Tile Flooring</td>
<td>Tarkett/ Gerflor/ Armstrong/ Forbe/ Trilux</td>
</tr>
<tr>
<td>58.</td>
<td>Paints - Cement Based</td>
<td>Snowcem Plus/, Berger (Durocem Extra)/ Nerolac (Super Acrylic)/ TATA Cem, Asian</td>
</tr>
<tr>
<td>59.</td>
<td>Paint – Fire Retardent</td>
<td>Viper FRS 881 / Nullfire</td>
</tr>
<tr>
<td>60.</td>
<td>Paints - Epoxy paint</td>
<td>ICI Dulux/ Nerolac / Cico / Sikka / BASF / Berger / Pidilite</td>
</tr>
<tr>
<td>61.</td>
<td>Paints - Oil Bound Distemper / Acrylic Washable Distemper</td>
<td>ICI Dulux/ Asian (Tractor)/ Berger (Bison)/ Nerolac (Super Acrylic), ICI (Maxilite)</td>
</tr>
<tr>
<td>62.</td>
<td>Paints - Other Paints / Primer</td>
<td>ICI Dulux/ Asian/ Berger/ Nerolac</td>
</tr>
<tr>
<td>63.</td>
<td>Paints - Plastic Emulsion Paint</td>
<td>ICI Dulux/ Asian/ Berger/ Nerolac</td>
</tr>
<tr>
<td>64.</td>
<td>Paints - Plastic Emulsion Paint (exterior)</td>
<td>Asian (Apex Ultima)/ Berger (Weathercoat all Guard)/ ICI (Dulux weathershield max)</td>
</tr>
<tr>
<td>65.</td>
<td>Paints - Synthetic Enamel Paints</td>
<td>ICI Dulux (Gloss), Berger (Luxol Gold), Asian (Apocolite), Goodlas Nerolac (Full gloss hard drying), Jenson &amp; Nicholson (Borolock)</td>
</tr>
<tr>
<td>66.</td>
<td>Paints - Texture paint</td>
<td>Berger / Spectrum / Unilite Heritage /Asian</td>
</tr>
<tr>
<td>67.</td>
<td>Paver blocks / Tiles (All Types)</td>
<td>KK / Uni Stone Products (India) Pvt. Ltd/ Hindustan Tiles/ NITCO</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>68.</td>
<td>Plywood/Block board/Ply board</td>
<td>Duroply / Greenply / Archidply / Century / Kitply / National / Anchor / Merino</td>
</tr>
<tr>
<td>69.</td>
<td>Polycarbonate Sheets</td>
<td>Danpanlon India / Gallina / GE Plastic / Tuflite</td>
</tr>
<tr>
<td>70.</td>
<td>Pre-coated Galvanised Steel Sheet</td>
<td>Tata BlueScope / Llyod Insulations India Ltd / S.R.Metals</td>
</tr>
<tr>
<td>71.</td>
<td>Pre-Laminated Particle Board</td>
<td>Novapan / Century / Green Ply / Merino</td>
</tr>
<tr>
<td>72.</td>
<td>PVC continuous fillet for periphery packing of glazings / Structural / Glazing</td>
<td>Roop / Anand / Forex Plastic / Nagalia / Trading Company</td>
</tr>
<tr>
<td>73.</td>
<td>PVC Doors</td>
<td>Sintex / Polyex / Rajshri</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>Powder Coating Material pure Polyester</td>
<td>Jotun / Berger / Goodlass Nerolac</td>
</tr>
<tr>
<td>76.</td>
<td>PVC Water Stops</td>
<td>Prince / Supreme / Finolesx</td>
</tr>
<tr>
<td>77.</td>
<td>RF Shielded Door</td>
<td>ETS Lindgren / Synchrony Agency / Huaming EMC India</td>
</tr>
<tr>
<td>78.</td>
<td>Reinforcement Steel / Structural Steel</td>
<td>SAIL / RINL / TATA Steel Ltd / Jindal Steel &amp; Power Ltd / JSW Steel Ltd.</td>
</tr>
<tr>
<td>79.</td>
<td>Restroom Cubicles</td>
<td>Merino / Century / Greenlam</td>
</tr>
<tr>
<td>80.</td>
<td>Sandwich Puff Panel</td>
<td>JSW / SINTEX or equivalent</td>
</tr>
<tr>
<td>81.</td>
<td>Sealant: Poly-sulphide</td>
<td>Pidilite / Fosroc / CICO / Sikka</td>
</tr>
<tr>
<td>82.</td>
<td>SFRC / RCC Manhole Covers / Perfect RCC Grating</td>
<td>KK Manholes / SK Precast Concrete / Advent concretevision / Daya concrete</td>
</tr>
<tr>
<td>83.</td>
<td>Silicon sealants / Weather Sealant / Structural Glazing Sealant</td>
<td>GE- Silicon / Pidilite / Fosroc / Cico / Dow Corning / Sikka / Wacker</td>
</tr>
<tr>
<td>84.</td>
<td>Stainless Steel</td>
<td>Salem Steel / Jindal or equivalent</td>
</tr>
<tr>
<td>85.</td>
<td>Outdoor Sports Flooring</td>
<td>Great Sports Infra / PORPLASTIC / Sunflex</td>
</tr>
<tr>
<td>86.</td>
<td>Stainless Steel bolts, Screws, Nuts &amp; Washers</td>
<td>Kundan / Puja / Atul</td>
</tr>
<tr>
<td>87.</td>
<td>Stainless Steel Clamps</td>
<td>Hilti / Intellotech Koncept or equivalent</td>
</tr>
<tr>
<td>88.</td>
<td>Stainless Steel CP Grating</td>
<td>Chilly / Camry / Neer or equivalent</td>
</tr>
<tr>
<td>89.</td>
<td>Stainless Steel D-handles</td>
<td>D-line / Giesse / Dorma</td>
</tr>
<tr>
<td>90.</td>
<td>Stainless Steel Friction Stay</td>
<td>Earl Bihari / Securistyle / EBCO</td>
</tr>
<tr>
<td>91.</td>
<td>Stainless Steel Hinges</td>
<td>Hettich / Godrej / Dorma</td>
</tr>
<tr>
<td>92.</td>
<td>Stone Adhesives</td>
<td>Fosroc / Sikka / Pidilite</td>
</tr>
<tr>
<td>93.</td>
<td>Sunken Portion Treatment</td>
<td>Choksey / Sika / CICO / MC Bouchemie / BASF</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>94.</td>
<td>Super plasticizer</td>
<td>CICO/ Roffes Construction Chemicals/ Pidilite /</td>
</tr>
<tr>
<td>95.</td>
<td>Tiles: Ceramic Tiles</td>
<td>Kajaria / Somany/RAK/</td>
</tr>
<tr>
<td>96.</td>
<td>Tiles: Glass Mosaic Tiles</td>
<td>MRIDUL/ BIZZARE</td>
</tr>
<tr>
<td>97.</td>
<td>Tiles: Glazed (Ceramic) tiles</td>
<td>Kajaria / Somany/RAK/</td>
</tr>
<tr>
<td>98.</td>
<td>Tiles: Heat Resistant Terrace Tiles</td>
<td>Thermatek or equivalent</td>
</tr>
<tr>
<td>99.</td>
<td>Tiles: Vitrified Tiles (Double / Multi Charged)/ Germ free</td>
<td>Kajaria / Somany/RAK</td>
</tr>
<tr>
<td>100.</td>
<td>Vacuum Dewatered Flooring</td>
<td>Tremix / Sun Build / Avcon technics</td>
</tr>
<tr>
<td>101.</td>
<td>Veneered Particle Board</td>
<td>Duro / Greenply / Century / Novapan / Action Tesa</td>
</tr>
<tr>
<td>102.</td>
<td>Vinyl Flooring</td>
<td>Wonder floor/ Responsive or equivalent make</td>
</tr>
<tr>
<td>103.</td>
<td>Water Proofing Materials (Bitumenistic)</td>
<td>BASF/ Fosroc / Sikka / CICO / STP/ Pidilite/CHRYSO</td>
</tr>
<tr>
<td>104.</td>
<td>Wooden Laminated Flooring</td>
<td>NITCO /Euro / Pergo</td>
</tr>
<tr>
<td>105.</td>
<td>Auditorium Chairs</td>
<td>Godrej/Spacewood/Indo</td>
</tr>
<tr>
<td>106.</td>
<td>Expansion Joints</td>
<td>Sanfield (India) Ltd., MIGUA, TRISTAR</td>
</tr>
</tbody>
</table>

**B. PLUMBING & SANITARY WORKS**

<p>| 1.   | Automatic variable temperature control / fixed temperature control faucets | Jaquar / AOS-Robo-U-Tec/ Parry / Angash / Euronics     |
| 2.   | Central Control                                                       | Rain Bird, USA/Toro/Nelson,                            |
| 3.   | Ball Cock                                                             | Sant / L&amp;T/Audco/GPA                                   |
| 4.   | Ball valves with floats                                               | Zoloto / Leader / Sant / Audco/GPA                     |
| 5.   | Brass - Stop &amp; Bib Cock                                               | Zoloto / Sant / Jaquar                                 |
| 6.   | C. I Pipes &amp; Fittings                                                | Electrosteel/ Kapilansh/ NECO/ RIF/ SKF/BIC           |
| 7.   | Centrifugally Cast Iron Hubless Pipes &amp; Fitting                      | NECO/BIC/SKF/Kapilansh                                 |
| 8.   | C.I Sluice Valve &amp; Non Return Valve                                  | Kirloskar /Leader / Zoloto/ Audco/ Sant               |
| 9.   | C.I Valves (Full way, Check and Globe Valves)                        | Leader / Kirloskar / SKF / Zolto / Sant / Castle / Kartar |
| 11.  | C.P. Fittings: Mixer / Bib Cock/ Pillar taps/ Angle valve/ Valves Washers / Waste/ Urinal / Spreaders / Accessories etc. | Jaquar /Kohler/ Grohe/Marc                           |
| 12.  | Centrifugally C.I Rainwater Intel fitting, Bronze gratings          | NECO/BIC                                              |</p>
<table>
<thead>
<tr>
<th>S.No</th>
<th>Details of equipment/ material</th>
<th>Make/Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.</td>
<td>Chlorinator</td>
<td>Thermax Ltd/ Watcon, Ion exchange/ Sigma DH Combine Inc./ Siemens/ Techcon/ Jesco/ Prominent Heidelberg</td>
</tr>
<tr>
<td>15.</td>
<td>Chlorine Dosing System</td>
<td>Toshcon / Chloromax</td>
</tr>
<tr>
<td>16.</td>
<td>Cockroach Trap</td>
<td>Chilly / Player/ Camry</td>
</tr>
<tr>
<td>17.</td>
<td>Copper Fittings (Capillary)</td>
<td>Yorkshire Imperial, U.K./ Rajco Metal Works Mumbai / IBP Conex Ltd.</td>
</tr>
<tr>
<td>18.</td>
<td>Disc Filter</td>
<td>Azud, Spain/ Amaid / Arkal,</td>
</tr>
<tr>
<td>22.</td>
<td>Forged Steel Fittings &amp; Flanges (For Welded joints)</td>
<td>Rohini / Kanwal/ Vijay Cycle &amp; Steel (VS)</td>
</tr>
<tr>
<td>23.</td>
<td>Geyser</td>
<td>Spherehot / Racold / Usha Lexus / Bajaj</td>
</tr>
<tr>
<td>24.</td>
<td>Hand Drier</td>
<td>Kopal / Utech Systems / Euronics Automat</td>
</tr>
<tr>
<td>25.</td>
<td>HDPE Pipes / Moulded Fittings</td>
<td>Emco / Polyefins/Pioneer Plyfab/ Jain</td>
</tr>
<tr>
<td>27.</td>
<td>Inbuilt Drip Line</td>
<td>Azud/ Rainbrid-USA/ Netafim</td>
</tr>
<tr>
<td>28.</td>
<td>Insulation of Hot water pipes</td>
<td>Vidoflex insulation / Superion insulation Kaiflex – Kaimann/Armofolex/Thermaflex</td>
</tr>
<tr>
<td>30.</td>
<td>Liquid Soap Dispenser</td>
<td>Euronics/Utec/Kopal</td>
</tr>
<tr>
<td>31.</td>
<td>MS Saddle with G.I. Riser</td>
<td>Harvel/ Alprene/Rain Bird, USA</td>
</tr>
<tr>
<td>32.</td>
<td>PVC flushing cistern</td>
<td>Commander / Parryware / Hindware / Cera</td>
</tr>
<tr>
<td>33.</td>
<td>P.R.S. Dials</td>
<td>Rain Bird, USA/ Toro, USA/ Nelson,</td>
</tr>
<tr>
<td>34.</td>
<td>P.T.M.T. Fitting</td>
<td>Prince India / Symet/ Pryag</td>
</tr>
<tr>
<td>35.</td>
<td>Pipe coat material (pipe protection)</td>
<td>RPG Raychem/ Pypkote/ Makphalt/ Lwl</td>
</tr>
<tr>
<td>37.</td>
<td>Pipe: G.I.</td>
<td>Jindal / Tata / Prakash Surya/ SAIL/ Swastik</td>
</tr>
<tr>
<td>38.</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>S.No</td>
<td>Details of equipment/ material</td>
<td>Make/Manufacturer</td>
</tr>
<tr>
<td>------</td>
<td>--------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>39.</td>
<td>Pipes &amp; Fittings: CPVC</td>
<td>Flowguard/ Astral/ Ashrivad/ AKG/ Supreme</td>
</tr>
<tr>
<td>40.</td>
<td>Pipes &amp; Fittings: UPVC</td>
<td>Finolex / Prince / Supreme / AKG / Kasta / Vector / Astral</td>
</tr>
<tr>
<td>41.</td>
<td>Pipes &amp; Gully Trap: Stone ware</td>
<td>Perfect / S.K.F/ R.K/ Hind / Anand</td>
</tr>
<tr>
<td>42.</td>
<td>Pipes and Accessories: PE-AL-PE</td>
<td>Kitec/ Jindal/ Kissan/Vista</td>
</tr>
<tr>
<td>43.</td>
<td>Pipes: Copper</td>
<td>Rajco Metal works, Mumbai / IBP Conex Ltd.</td>
</tr>
<tr>
<td>44.</td>
<td>Pipes: M.S.</td>
<td>Jindal / Prakash – Surya / TATA</td>
</tr>
<tr>
<td>45.</td>
<td>Pipes: PP-R (PN – 16)</td>
<td>Amitex Polymers Pvt. Ltd. / Prince / Supreme</td>
</tr>
<tr>
<td>46.</td>
<td>Pipes: R.C.C</td>
<td>Indian Hume Pipe / Pragati Concrete Udyog Daya/ KK / JSP</td>
</tr>
<tr>
<td>47.</td>
<td>Plastic seat cover of W.C</td>
<td>Commander/Hindware / Parryware</td>
</tr>
<tr>
<td>48.</td>
<td>Polyethylene Storage Tank</td>
<td>Sintex / Polycor / Fusion</td>
</tr>
<tr>
<td>49.</td>
<td>Pop up Connecting Assembly</td>
<td>Rain Bird/Dura/Lasco,</td>
</tr>
<tr>
<td>50.</td>
<td>Popup Spray Head</td>
<td>Rain Bird/Toro, USA/Nelson,</td>
</tr>
<tr>
<td>51.</td>
<td>RQRC Hydrant</td>
<td>Harvel/Alprene/Rain Bird, USA</td>
</tr>
<tr>
<td>52.</td>
<td>RQRC Key</td>
<td>Harvel/ Aqua/ Drip &amp; Drip</td>
</tr>
<tr>
<td>54.</td>
<td>SS Gratings/ Soap Dish/Towel Rail etc.</td>
<td>Camry/Glacier/Gem / Jaquar/ Grohe</td>
</tr>
<tr>
<td>55.</td>
<td>Stainless Steel Sink</td>
<td>Hindware / Neelkanth / Nirali / Jayna</td>
</tr>
<tr>
<td>56.</td>
<td>Valve Box</td>
<td>Rain Bird, USA/ Carson Brook, USA/Dura,</td>
</tr>
<tr>
<td>57.</td>
<td>Valve: Air Release</td>
<td>Azud/ API/ Bermad/ BIR/ Kirloskar / Venus / Zoloto</td>
</tr>
<tr>
<td>58.</td>
<td>Valve: Butterfly</td>
<td>Zolato/Audco / Sant/ KSB</td>
</tr>
<tr>
<td>59.</td>
<td>Valve: Gun metal</td>
<td>Kilburn / Leader / Zoloto/ Sant/ Kartar/ AIP/ Audco</td>
</tr>
<tr>
<td>60.</td>
<td>Valve: Flush</td>
<td>Gem/ Jaquar / Marc</td>
</tr>
<tr>
<td>61.</td>
<td>Valve: Mainline Isolation</td>
<td>Sant / Leader / Zoloto,</td>
</tr>
<tr>
<td>62.</td>
<td>Valve: Pressure Relief</td>
<td>Sant/Leader / Zolato / Audco</td>
</tr>
<tr>
<td>63.</td>
<td>Valve: Sluice / NRV</td>
<td>Kirloskar/ IVC/Kilburn /Zoloto/ Castle/ Leader / L&amp;T / Audco</td>
</tr>
<tr>
<td>64.</td>
<td>Valve: Solenoid</td>
<td>Rain Bird, USA/Toro/Nelson,</td>
</tr>
<tr>
<td>65.</td>
<td>Valve: Non Return</td>
<td>Sant/ Leader / Zoloto / AIP / Kirloskar/ IVC/ Leader/ Audco</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>66.</td>
<td>Valves: Gunmetal / C.P brass angle</td>
<td>Zoloto / Leader / Kilburn / Sant / Kartar / AIP / Audco</td>
</tr>
<tr>
<td>67.</td>
<td>VFD Pump</td>
<td>Jyoti / Crompton / Kirloskar / KSB / Grundfos / Mather &amp; Platt</td>
</tr>
<tr>
<td>68.</td>
<td>Vibration Eliminator Resista-flex Pads &amp; Connections</td>
<td>Relay Corpn. / Kanwal</td>
</tr>
<tr>
<td>69.</td>
<td>Vitreous China Sanitary wares</td>
<td>Hindware / Parryware / Cera / Kohler</td>
</tr>
<tr>
<td>70.</td>
<td>Water Cooler</td>
<td>Blue Star / Voltas / Usha / Godrej</td>
</tr>
<tr>
<td>71.</td>
<td>Water Meter</td>
<td>Capstan / Kranti / Anand / Kant</td>
</tr>
<tr>
<td>72.</td>
<td>Water supply pumps</td>
<td>KSB / Grunfos / Kirloskar / Crompton / Mather &amp; Platt</td>
</tr>
<tr>
<td>73.</td>
<td>White Glazed Fire Clay Sink</td>
<td>Hindware / Parryware / Cera</td>
</tr>
</tbody>
</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. This list of makes shall be read with the list of makes provided elsewhere in the Tender Documents. In case of variance, decision of the Engineer-in-Charge shall be final.

4. For materials/equipment/ to be used in items of work for which approved makes are not given hereinor in the list of makes provided elsewhere in in the Tender Documents, the makes of such materials/equipment shall be as decided by Engineer –in-charge.

5. 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.
CHAPTER –F

TECHNICAL SPECIFICATIONS – ELECTRICAL & LOW VOLTAGE WORKS

1. GENERAL

A new AIIMS Complex comprising of Hospital Block, Ayush Hospital, Medical & Nursing College, Hostel Blocks for UG & PG Students, Nurses Hostel, Auditorium, Guest House, Dining Hall, Cafeteria, Night Shelter, Shopping Complex, Directors’ Residence, Housing Blocks and Service Blocks etc. is proposed to be constructed.

2. SCOPE OF WORK

The scope of work shall cover internal Electrical Installations, ESS and external electrical Installation works complete as required for Electrification of proposed AIIMS Campus. It shall covers designing of complete Electrical system for the entire complex, preparation of shop drawings, supply of all equipment, material, electrical Fixtures & Accessories required, installation, testing and commissioning of all electrical installations for the project for the following, but not limited to, main items/systems:

2.1 ESS & External Electrical Installation

i. 11 KV/ 0.433 kV Sub-Station - 2 Nos. comprising but not limited to following:
   a. 11 KV VCB Panel Board
   b. Cast Resin Dry Type Transformers with OLTC & RTCC Panels
   c. LT Panel with Synchronizing Relay for auto synchronizing and Auto-load management
   d. Capacitor Panels (APFC) with Hybrid Harmonic filters to improve Power factor up to 0.97 (lagging) & mitigation of harmonics.
   e. Sandwich Bus Ducts from Transformers to LT Panel, DG Sets to LT Panel, LT Panel to HVAC Panel, LT Panel to Capacitor Panels etc.
   f. All Associated Equipment & accessories required

ii. 11 kV underground Ring Main System interconnecting all Substations

iii. DG Sets including Synchronizing relay and PLC panels for Auto Synchronizing, Auto Load Management & Load sharing etc.

iv. Lightening Protection System & Earthing Network

v. 11 kV HT Power Cables and 1.1 kV LT power cables

vi. Solar & Conventional Street Light System

vii. Boom Barriers

viii. Electrical distribution comprising of feeder cables from ESS to individual block, services, Main panel, Rising Mains etc. Separate distribution shall be provided for Lighting load, Power/AC Load, Medical Equipment & UPS load. Separate LT panels at each floor shall be provided for feeding HVAC load of AHUs, FCUs, Split ACs and Ventilation Fans.

The Electrical distribution should include - Emergency power supplying distribution system as per NBC 2016 for critical requirement for functioning of fire and life safety system and equipment, shall be planned for efficient and reliable power and control supply to the following systems and equipment where provided:

i. Fire pumps
ii. Pressurization and smoke venting; including its ancillary systems such as dampers and actuators;

iii. Fireman's Lifts (including all lifts).

iv. Exit Signage Lighting;

v. Emergency Lighting;

vi. Fire Alarm System;

vii. Public Address (PA) System (relating to emergency voice evacuation and annunciation);

viii. Access Control System

ix. Lighting in fire command centre and security room.

x. Any other system as required

2.2 Internal Electrical Installations

It shall include the following items of work to be carried out simultaneously with the civil work within the buildings:

i. Wiring for 6A Light Points and socket Outlets

ii. Wiring for Call Bell, Fan & Exhaust Points.

iii. Wiring for 16A/20A Power socket outlets.

iv. Wiring for 3 Phase Power socket Outlets

v. 1.1 KV L.T. Cables and Sub main wiring.

vi. Rising Mains / Bus Trunking

vii. M.V. Panels/ Floor Panels and Double Door MCB Type Distribution Boards.

viii. Supply and Installation of LED Light fittings, fans, Exhaust Fans & fixtures

ix. Earthing & Lighting Arrester

x. Wiring for Telephone

xi. Wiring for Cable TV

xii. Wiring for LAN Networking & Hospital Management Information System (HMIS)

xiii. Wiring for CCTV & Access Control System, Boom Barriers

xiv. Testing and commissioning of all electrical installations

The scope of work shall also include any other item or item of work, equipment, material or accessories not specifically mentioned above but is required for the satisfactory completion & trouble free operation & maintenance of electrical equipment/ work. This shall also include spares required for commissioning of the equipment/work

2.3 SPECIAL CONDITIONS FOR ELECTRICAL SERVICES:

a) 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.

b) 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. The 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 / Engineer In Charge.

The HITES shall have full power regarding the materials or work to be got tested through independent agency at the EPC 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, there under 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.

2.4 DRAWINGS

i. Tender Drawings:

The tender drawings are meant to give general idea to bidder regarding the nature of scope & works to be executed. Any information/data not shown in tender drawings shall not relieve the contractor of his responsibility to carry out the work as per the specifications & terms of the EPC contract. Additional information required by the bidder/tenderer for successful completing the work shall be obtained at his end.

ii. Shop Drawings:
The contractor shall prepare detailed coordinated electrical shop drawing indicating Light Points, Power Points, Cal Bell points, Ceiling Fan, Exhaust Fan Points, Switch Boards, Distribution Boards (Light, Power & UPS), Lighting Fixtures, Convenience outlets, Single Line Diagram for complete HT/ LT electrical scheme, DG Sets, HT Panel, Transformers, LT Panels, Capacitor Panels, RTCC Panels, PCC Panel, UPS Units, UPS Incoming/ Outgoing panels, Lift Panels, Rising Mains, HT/ LT Cable Schedules, Solar PV System, Earth Pit Layout, Earth Strip routes, HT/ LT Cable Routes, Street Light Layout & Street Cable routes, Schematic Diagrams & Floor wise Shop Drawings for all LV works namely, Telephone, LAN, Wifi, CCTV, Access Control, Fire Alarm, Public Adress System, Information Display System, Boom Barriers etc. with other relevant services and submit to the HITES for approval or the Engineer-in-Charge before commencing the work.

GA Drawings, SLD & Control wiring diagrams, Room trench details for all HT & LT Panels, Capacitor Panels, UPS panels, Floor Electrical Panels, Transformers, DG Sets, UPS Units, Rising Mains etc. shall be prepared & submitted. The shop drawings shall indicate all setting out details and physical dimensions of all equipment/items/ components with wiring and cable details, cable schedule and routes, manhole trap and fixing details as well as for conduit indicating run and size of wire/cables, outlet/pull/junction boxes etc. with fixing details etc. for the above mentioned work. All work shall be carried out on the approval of these drawings. However, approval of these drawings shall not relieve the contractor of his responsibility for providing maintenance free and fool proof system including any missing component/accessories to meet the intent of the specifications. Contractor will submit 2 prints for preliminary approval and finally six prints for distribution. The recommended location/ position of the all equipment as shown on the layout drawings will be adhered to unless stated otherwise.

iii. As-Built Drawings:

On completion of the work and before issue of certificate of virtual completion, the contractor shall submit to the HITES, required Sets of ‘As Built’ drawings (in AutoCAD & PDF
format) along with soft copy of the executed works incorporating all such changes and modifications during engineering and execution along with Operation and Maintenance Manuals, Warranty & Guarantee Certificates from Original Equipment Manufacturers (OEM), authorized Suppliers & Vendors, as applicable.

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 Transformers, HT/ LT Panels, Feeder Pillars, capacitor control panels etc.
- 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 DG Sets, 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.

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.

2.5 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.

2.6 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.

2.7 GENERAL DETAILS

a) 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.

b) **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.

c) **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.

d) **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 specifications / General arrangement, 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.

2.8 **Rating Plates, Name Plates and Labels**

Rating Plates, Name Plates and Labels are to be provided & attached permanently in a conspicuous position to all equipment & items installed in various buildings. A rating plate of non-corrosive material engraved with manufacturer’s name, year of manufacture, equipment name, diagram, type or serial number etc. together with details of the loading conditions of equipment. The rating plate of each equipment shall be according to relevant BIS & IEC norms, as applicable.

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.

2.9 **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.

2.10 **DESIGN IMPROVEMENTS / DEVIATIONS**

Tender No. HITES/AIIMS-Guwahati/2018
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.

3. **QUALITY ASSURANCE PROGRAMME**

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 HITES inspection points as mutually and methods used to verify the inspection and testing points in the quality plan were performed satisfactorily.

4. INSPECTION, TESTING AND INSPECTION CERTIFICATE

• The HITES or duly authorized representative shall have at all reasonable times free access to the Contractor’s/ 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.

• 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 tools and testing facilities for inspection purpose including arrangement of air travel (inland as well as abroad), conveyance, lodging, boarding and other miscellaneous expenses etc. HITES shall depute its inspection engineers (2 or more as decided by HITES) after receipt of inspection call from the contractor. All such expenses incurred
by the contractor towards inspection of equipment by HITeS' inspection engineers shall be borne by the contractor.

- 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 absolve 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 test(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.

5. TESTS

5.1. Charging Tests

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.

5.2. 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.

6. 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.
7. **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.

8. **FINISHING OF METAL SURFACES**

8.1. **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.

8.2. **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.

8.3. **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 sanded.

- 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.

9. 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 the HITES. 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.

10. 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.

11. 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.

12. DESIGN COORDINATION MEETING

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

13. 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.

14. SAFETY CODES & PRECAUTIONS

The Contractor at his own expenses shall arrange for safety provisions as required to comply with the statutory regulations, ISI recommendations and CPWD codes.

The contractor shall provide necessary barriers, warnings, signals and other safety measures to avoid accidents. He shall indemnify HITES against any claims arising out of negligence in this respect.

15. REGULATIONS AND STANDARDS

All equipments their installation, testing and commissioning shall conform latest CPWD/ IS specifications in all respects. Indian Standard Code of Practice for Electrical Wiring Installation IS:732-1989. It shall also be in conformity with Indian Electricity Rules and the Regulations, National Electric Code, National Building Code 2016, ECBC, latest CPWD specifications amended up to date and requirements of the Local Electric Supply Authority. In general, all materials equipment and workmanship shall conform to the Indian Standards specifications and code. Some of the applicable codes/standards are as under:

<table>
<thead>
<tr>
<th></th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>CPWD General specifications for electrical works</td>
</tr>
<tr>
<td></td>
<td>Part-I (Internal) 2013</td>
</tr>
<tr>
<td>b</td>
<td>CPWD General specifications for electrical works</td>
</tr>
<tr>
<td></td>
<td>Part-II (External) 1994</td>
</tr>
<tr>
<td>c</td>
<td>CPWD General specifications for electrical works</td>
</tr>
<tr>
<td></td>
<td>Part-III (Lifts &amp; Escalators) 2005</td>
</tr>
<tr>
<td>d</td>
<td>CPWD General specifications for electrical works</td>
</tr>
<tr>
<td></td>
<td>Part-IV (Substation) 2013</td>
</tr>
<tr>
<td>e</td>
<td>CPWD General specifications for electrical works</td>
</tr>
<tr>
<td></td>
<td>Part VII (DG Sets) 2013</td>
</tr>
<tr>
<td>f</td>
<td>Guide for uniform system of marking and identification of conductor and apparatus terminals.</td>
</tr>
</tbody>
</table>
g. Low voltage switchgear and control gear assemblies IS/IEC 61439
h. Specification for low voltage switchgear and control gear assemblies IS 8623 (Part -2-1993)
i. Code of practice for selection, Installation and maintenance of switchgear and control gear. IS 10118 Part – 1 - 4
j. PVC insulated (heavy duty) electric cables IS 1554
k. PVC insulated cables for working voltages up to and including 1100V. IS 694
l. Conduit for electrical installations IS 9537
m. Accessories for rigid steel conduits for electrical wiring IS 3837
n. Boxes for the enclosure of electrical accessories IS 14772
o. General and safety requirements for luminaries IS 1913
p. Code of practice for earthing IS 3043
q. Electrical accessories – circuit breakers for over current protection for household and similar installations. IS 8828
r. Low Voltage switchgear and control gear IS 13947 Part 1 – 5
s. Residual current operated Circuit Breakers IS 12640
t. Current Transformers IS 2705
u. Voltage Transformers IS 3156
v. Direct acting indicating analogue electrical measuring instruments and their accessories IS 1248 part – 1 to 9
w. Control Switches (switching device for control and auxiliary circuits including contactor relays) for voltages up to and including 1000V AC and 1200 V DC. IS 13947 & IS 1336

In case of contradiction in specification the priority of the documents shall be CPWD/ IS Specifications, Drawings, Technical Specifications.

16. 11 kV/ 0.433V SUBSTATIONS

16.1. 11 kV VACUUM CIRCUIT BREAKER (VCB) PANEL BOARD

16.1.1. 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. 11KV Panel board in each Substation shall be comprising of 2 Incoming Panels, One Bus coupler & Outgoing Panels with provision of at least one no. spare Breaker panels on each side. All VCBs shall be controlled and monitored with SCADA System.

16.1.2. 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

- 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.

- 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.

- 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.

- It shall be horizontal isolation, horizontal draw out type, fully interlocked, with dust and vermin proof construction, suitable for indoor installation. The panel shall be supplied with the manufacturer’s test certificates.

- 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.

- 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.

- 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 fixed/withdraw able 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.

- 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.

- 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.

- Mechanically operated circuit breaker auxiliary switches of minimum 5 NO + 5 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.
- 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.
- 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.

16.1.3. 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.
- Busbar insulators shall be of track-resistance, high strength, and non-hygrosopic, 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.

- 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.

- 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 requirement of the client.

- **Metering and Protection to be provided in Panels shall be as detailed below:**

<table>
<thead>
<tr>
<th>INCOMING PANELS - 800 A 11 kV VCB BREAKER PANEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Set -11KV/110Volts , 3 phase PT Class -0.5 accuracy and 100 VA burden with 1 No. Voltmeter (0-1.5KV), digital type with built-in selector switch and protection MCBs for HT metering up to 12 KV on Incomer (IS-3156)</td>
</tr>
<tr>
<td>1 Set- Ammeter Digital Type with built -in selector switch.</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>
</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>
</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>
</tr>
<tr>
<td>1 Set R/Y/B phase LED indication lamp</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>
</tr>
<tr>
<td>1 Set of Push button for Emergency Tripping with 1 NO + 1 NC contacts &amp; inscription plates.</td>
</tr>
<tr>
<td>1 Set Trip / Neutral / Close Breaker Control Switch.</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>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OUTGOING PANELS- 630 A, 11 kV VCB BREAKER PANEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 set Ammeter digital type with built-in selector switch.</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>
</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>
</tr>
<tr>
<td>1 set R/Y/B phase LED indication lamp</td>
</tr>
<tr>
<td>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)</td>
</tr>
<tr>
<td>1 set of Push button for Emergency Tripping with 1 NO + 1 NC contacts &amp; inscription plates.</td>
</tr>
<tr>
<td>1 set Trip / Neutral / Close Breaker control switch.</td>
</tr>
<tr>
<td>1 set calibrated intelligent multi function digital panel meter of class- 1.0 accuracy with communication inter face port RS 485 for giving output on BACNET / MOD BUS protocol of IBMS for receiving V, A, KVA, KVAh, KW, KWH,F, KVAR &amp; PF etc. complete with wiring.</td>
</tr>
<tr>
<td>1 Set 8 window solid state audio/ Visual Annunciators with Test/ Accept/ Reset push buttons and Electronic Hooter.</td>
</tr>
<tr>
<td>1 Lot - Master Trip Relays / Lockout Relays / Anti pumping / Aux. Relays/ Over current/ Earth Fault for Outgoing VCB feeder as required.</td>
</tr>
</tbody>
</table>

The Incoming & Outgoing VCBs panels shall SCADA/BMS compatible.

### 16.1.4. 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**: Vacuum Circuit Breaker shall be provided with the following safety and interlocking arrangements:
  
i. The draw out carriage cannot be moved from either test/disconnected to service position or vice versa, when the circuit breaker is ‘On’.
  
ii. The circuit breaker cannot be switched ‘ON’ when the carriage is in any position between test & service position.
  
iii. The front door of the panel cannot be opened when the breaker is in service position or in an intermediated position.
  
iv. The low voltage plug & socket cannot be disconnected in any position except test/isolated position.
  
v. The door cannot be closed unless the LV plug has been fitted.
  
vi. 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.
  
vii. 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.
  
viii. Circuit Breaker & sheet metal enclosure shall be fully earthed.
  
ix. Self locking shutters shall be provided which close automatically and shall be interlocked with the movement of the draw out carriage mechanism.

- **Rating**: The rating of the vacuum circuit breaker shall be as below

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated current</td>
<td>800A for I/C and 630 A for O/G Panels</td>
</tr>
<tr>
<td>Rated Voltage</td>
<td>11 KV</td>
</tr>
<tr>
<td>Rated Frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Rated Breaking capacity</td>
<td>18.37 kA (350 MVA)</td>
</tr>
<tr>
<td>Rated making capacity</td>
<td>As per relevant standards.</td>
</tr>
</tbody>
</table>

- **Accessories**: Circuit Breakers shall be provided with the following accessories.

  i. Auxiliary Switch with minimum 5 NO + 5 NC auxiliary contacts.
  
  ii. Tripping Coil
  
  iii. Mechanical Operation Counter
  
  iv. Spring Charging Handle

- **Mounting**: Vacuum Circuit Breakers shall be mounted as per manufacturer’s standard practice.

- **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
16.1.5. TESTS

- **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 contractor shall submit the routine test certificates for the following equipment.
    
    i. Circuit Breakers
    
    ii. Current Transformers
    
    iii. Voltage Transformers
  
d. Temperature rise test.
  
e. Impulse & power frequency voltage test
  
f. Short time current test on circuit breaker.

- **Site Test**
  
  **General**
  
  1. Verification for completion of equipment, physical damage/deformities.
  
  2. Alignment of panel, interconnection of busbars & tightness of bolts & connection etc.
  
  3. Interconnection of panel earth busbar with plant earthing grid.
  
  4. Inter panel wiring between transport sections.
  
  5. Cleanliness of insulators and general Cleanliness of panel to remove traces of dust, water etc.
  
  **Circuit Breaker & Panel**
  
  1. Check for free movement of circuit breaker, lubrication of moving part & other parts as per manufacturers manual.
  
  
  3. Meggar before the Hi Pot test.
  
  4. 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.
  
  5. Meggar after the Hi Pot test.
  
  6. CT/PT ratio/polarity primary injection test.
  
  7. Secondary injection test on relays to practical characteristics.

16.2. 11 KV HT CABLES

The quantity of 11 kV HT cable required for the following is included in the scope of works of the tender:
1. Incoming feeders from 11 kV HT Panel located in 33/11 KV Substation of APDCL to HT Panels in ESS-1 and ESS-2.

2. 11 kV cable for underground Ring Main System interconnecting ESS-1 with ESS-2.

3. 11 kV cables from HT Panels to Transformers in ESS-1 & ESS-2 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.

16.2.1. Construction

All HT cables shall be of 11 kV grade, armored, aluminum conductor, XLPE insulated, earthed & PVC sheathed. All HT cables shall be manufactured & tested in accordance with relevant IS Code Specifications.

16.2.2. 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.

16.2.3. 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 cost of cables/cable laying.

16.3. LT PANELS

16.3.1. GENERAL

The scope of supply covers design, fabricate, integrate, pack, dispatch 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' here forth). 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/SCADA compatible and wired accordingly so that all relevant electrical parameters can be communicated to BMS/SCADA system. All necessary wiring, cabling etc between LT Panels, Sub- Panels etc and BMS/SCADA shall be carried out as per norms. All Incoming & Outgoing feeders of Main LT Panels located in Substations shall be controlled and monitored through SCADA 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-62 for Outdoor Panels. All Outdoor Panels shall be weather proof, Double Door with suitable canopy on top. The short circuit current rating of LT switchgears shall be ≥ 50 kA.

All LT Panels shall be provided with necessary instruments for Monitoring & Metering purpose to meet ECBC & GRIHA requirements.

All incoming feeders of LT panels shall have R, Y, B, ON, OFF & Trip LED Type indication lamps. All outgoing feeders of LT panels shall have ON, OFF & Trip LED Type indication lamps.
Multifunction meters with BMS compatibility shall be provided in all incoming feeders of all LT Panels to be installed in AIIMS Campus. Suitable digital energy meter with CTs, wiring etc. shall be provided for all outgoing feeders of all LT panels to be installed in OPD, Hospital, AYUSH, Medical & Nursing College and Auditorium buildings.

Main LT Panels in ESS buildings shall have Multifunction meters with BMS compatibility in all Incoming Feeders & all Outgoing Feeders.

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. Location - Indoor,
b. Altitude above main sea level - < 2000M above sea level.
c. Design Ambient Temperature - 40 Deg. C
d. Temperature rise - As per IEC 61439
e. Relative Humidity Max - 95%
f. Relative Humidity Min - 10%
g. Pollution - Up to Degree of pollution-3
h. Application - Indoor

16.3.2. CONSTRUCTION-

a) Standards

The equipment covered under this specification shall conform to the latest revisions of relevant Indian and International Standards some of which are listed below:

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.

b) Main/Sub Panels shall be:

i. Of metal enclosed, indoor, floor mounted, free standing construction (unless otherwise specified) type.

ii. ade up of the requisite vertical sections, which when coupled together shall form continuous dead front switchboards.
iii. Provide dust and damp protection.

iv. Be readily extensible on both sides by the addition of vertical sections after removal of the end covers in case of Main Panels.

v. All panels shall be front access type.

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:

i. 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.

ii. 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.

iii. 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.

iv. 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.

The height of the panels should not be more than 2400 mm for MV 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.

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.

Apparatus forming part of the Main/Sub Panels shall have the clearances more than as given below.

1. Between phases - 32 mm
2. Between phases and neutral - 26 mm
3. Between phases and earth - 26 mm
4. 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:

i. Main busbars and vertical risers during operation, inspection or maintenance of functional units and front mounted accessories.

ii. 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.

16.3.3. 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:-

i. Effective cleaning by hot alkaline degreasing solution followed by cold water rinsing to remove traces of alkaline solution.

ii. Pickling in dilute sulphuric acid to remove oxide scales & rust formation, if any, followed by cold water rinsing to remove traces of acidic solution.

iii. 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.

iv. Passivating in de-oxalite solution to retain and augment the effects of phosphating.

v. Drying with compressed air in a dust free atmosphere.

vi. Panel shall be powder coated with epoxy based powder paint after the above process so as to render the material suitable for corrosive environment.

vii. Paint shade shall be Pebble (light) grey, shade No RAL 7032 unless otherwise specified.

16.3.4. 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 200 Amp; 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 20% spare terminals shall be provided for future use. Control terminal block shall be separated from power terminal blocks by means of an insulating barrier.

16.3.5. SWITCHGEARS

Refer 16.4 – LT switchgears

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.

16.3.6. 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 through out 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.

16.3.7. 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 mm2. However, CT circuit wiring shall be done with 2.5 mm2. 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.

16.3.8. 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.

16.3.9. TEST AT MANUFACTURES WORK

All routine tests specified in IS: 8623-1977 shall be carried out and test certificates submitted.

16.3.10. 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.

16.4. LT SWITCHGEARS

16.4.1. AIR CIRCUIT BREAKERS

• 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.

• 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.

- **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.

- **INTERLOCKING AND SAFETY ARRANGEMENT**

Air Circuit Breakers shall be provided the following safety and interlocking arrangements:

i. It shall not be possible for breaker to be withdrawn when in "ON" position.

ii. 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.

iii. The breaker shall be capable of being racked into 'testing', 'isolated' and 'maintenance' positions and kept locked in any of these positions.

iv. 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.

v. 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.

- **RATING**

The rating of the circuit breaker shall be as per the DBR/ drawings. Rated service breaking capacity (Ics) 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 (Icu) and short circuit withstand values (Icw) for 1 sec.
• 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, Iavg, 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.

• MOUNTING

Circuit Breakers shall be mounted as per manufacturers' standard practice.

• 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.

i. Impulse withstand test.
16.4.2. MOULDED CASE CIRCUIT BREAKERS.

**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 0.4In to 1.0 In.

**Technical Specifications**

The MCCB should be current limiting type with trip time of less than 10 milli sec under short circuit conditions. All MCCB should be 4 poles type unless stated otherwise.

MCCB shall comply with the requirements of the relevant standards IS13947 – 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 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.

**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.

• BREAKING CAPACITY

All MCCB shall be 4 pole type and shall have following short circuit current rating/breaking-

- MCCB rating below 250 A – 25 kA
- MCCB rating 250 A and above upto 800 A – 36 kA
- MCCB rating 800 A – 50 kA

The rated service breaking capacity should be equal to rated ultimate breaking capacities (Ics=Icu).

• 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.

16.5. MEASURING INSTRUMENTS, METERING & PROTECTION

16.5.1. GENERAL

Direct reading electrical instruments shall be in conformity with IS 1248. The accuracy of direct reading shall be 0.5 for voltmeter and 0.5 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 DBR/Drawings.

16.5.2. 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.

16.5.3. DIGITAL VOLTMETERS

Voltmeters shall be standard digital type. The voltmeters 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.

16.5.4. 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

16.6. MISCELLANEOUS

- 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.

- 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.

- 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.

16.7. LT CABLES

16.7.1. 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>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>2</td>
<td>IS 694 : 2010</td>
<td>XLPE insulated (heavy duty ) electric cables. For working Voltages up to and including 1100 V ( third revision)</td>
</tr>
<tr>
<td>3</td>
<td>IS: 7098: 1988 (Part-I)</td>
<td>PVC insulated ( heavy duty) electric cables with solid aluminium conductors for voltages up to and 1100 V ( second 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>

16.7.2. 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 otherwise stated.

b) For LT Power cable sizes above 16 sqmm, cables shall be XLPE insulated, PVC sheathed, Aluminium conductor armoured cables, unless otherwise stated.

c) LT Control cables shall be XLPE insulated PVC sheathed type copper conductor armoured cables, unless otherwise stated.

d) All LT Power & Control cables shall conform to IS: 7098: 1988 (Part-I) with up to date amendments.

16.7.3. 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.

16.7.4. INSPECTION

All cables shall be inspected at site and checked for any damage during transit.

16.7.5. 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.

16.7.6. 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 ground level for LT Cables and 1.20 meter below 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 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.

16.7.7. 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 cost of cables/cable laying.

16.7.8. 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 the shall be laid at a depth of 1000 mm.

16.7.9. 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.

16.7.10. LAYING OF CABLES ON CABLE TRAY/SURFACE OF WALL/ CEILING

Cable shall be laid on perforated M.S. 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.

16.7.11. 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.

16.7.12. 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 glanding 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.

16.7.13. 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.

i. Before laying.
ii. After laying.
iii. 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.

i. Insulation Resistance Test (Sectional and overall).
ii. Continuity Resistance Test.
iii. 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.

16.8. CABLE TRAY

16.8.1. 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.

16.8.2. Perforated Type Cable Tray

i. The cable tray shall be fabricated out of slotted/perforated M.S. 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 cable 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 MS 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.

16.9. SANDWICH BUS DUCTS/TRUNKING, RISING MAINS

16.9.1. 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.

16.9.2. 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.

16.9.3. 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.

16.9.4. Manufacturer:

The manufacturer must have an established track record in design and manufacture of sandwich busbar trunking system, and must have supplied busbar trunking systems for at least 20 years.

16.9.5. Design & Construction requirements:

- **General:**
  
  The Busbar Trunking System shall be of sandwich construction, non-ventilated and natural cooled design. It shall be possible to mount the Busbar Trunking System in any orientation without affecting the current rating.

- **Busbars:**
  
  - The busbars should be made of high conductivity electrical grade Aluminum with conductivity >60%
  
  - Purity of Aluminum conductor should not be less than 99.6%
  
  - Aluminum busbars should be Tin plated at the joint area
  
  - 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.

- **Insulation:**
  
  - 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.
  
  - The insulation material used shall be of minimum Class F (155 deg. C)
  
  - Insulation must be Halogen free & RoHS compliance

- **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.

- **Joints:**
  
  - The joint design shall have inbuilt provision of absorbing expansion & contraction of 12mm per joint during operation.
  
  - The joint insulation must be of single piece moulded design of thermoset material for longer life and higher temperature withstand & better insulation property.
  
  - The joint construction must allow +/- 3mm adjustment at the time of installation, for ease of adjusting to site measurement variations.
  
  - The joint bolt must be insulated with a bolt insulator. The bolt insulator must be of molded one piece.
  
  - The joint design shall have inbuilt provision to prevent excessive insertion of busduct which can damage the bolt insulator.
  
  - 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.

- It shall be possible to install and remove the joints without disturbing the adjacent feeder section
- Joint set should have insulators with temperature withstand capacity of class-F

- **Plug-in Unit / Tap off units :**
  - 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.
  - Each section of Bus Bar enclosure plug in ports spread at interval of approximately 600 mm for the insertion of plug in boxes.
  - 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.
  - When the MCCB in the Plug-in unit is in 'ON' position, the operator should not be able to open the door.
  - The design of plug-in units shall be such that, the PE conductor shall be of 'First-Make' 'Last-Break' type.
  - 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.
  - Plug-in unit must achieve IP-54 protection
  - Plug-in units should be plug-in type up to 400A & Bolt-on Type from 630A
  - 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

- **Routine & Type Tests :**
  - 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)
  - 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
  - Degree of ingress protection (IP rating) shall also be tested at any reputed independent laboratory as per IEC-60529
  - Dielectric test.
  - Busduct should be tested for minimum Seismic Zone-4 & High Seismic Qualification level as per IEEE:693

- **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.

16.10. CAPACITOR PANEL & HYBRID HARMONIC FILTER

16.10.1. 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. 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.

Hybrid Harmonic filter shall comprise two separate panels for harmonic correction and power factor improvement. Harmonic compensation shall be done through IGBT based Active Harmonic filter and Power factor correction shall be done through Automatic Power Factor Correction panels with passive tuned filters.

- RATING

The rating of Capacitor units shall be as per CPWD specifications for Electrical Works (Part-4) Substations 2013.

16.10.2. ACTIVE HARMONIC FILTER

- Active Harmonic Filter to mitigate low voltage system harmonics

The Active Harmonic Filter (Type AHF) is intended to remove harmonic distortion from the phase conductors in a 3-phase electrical system resulting in reduced phase current, reduced current distortion and reduced upstream electrical system harmonic voltage distortion.

- Principle of operation

AHF should measure level of harmonics in supply line and eliminate it by generating the counter harmonics. It should employ a DSP which determines the harmonic current amplitude to be injected in the opposite phase angle of each harmonic order.

The active filter shall not only provide harmonic mitigation, but also, power factor correction and load balancing. Harmonic correction, PF correction and Unbalance correction should be able to set with priority and filter should work to employ the priority as per the user settings.

a. The active harmonic filter shall mitigate harmonics from the 2nd harmonic up to the 15th harmonic and limit harmonic distortion at their point of connection to within the harmonic limits specified herein. The active filter shall be connected in parallel (shunt) to the load.

b. The active filter shall be suitable for connection at an electrical distribution panel, transformer secondary or at an individual load.

c. The active filter shall be suitable for connection to a distorted voltage source and its operation shall not be adversely affected by pre-existing voltage distortion.

d. The active filter shall be suitable for operation on an electrical system having a generator as its power source.

e. AHF should have high attenuation up to 96% of individual harmonics
f. AHF shall allow user to select any 10 order of harmonics out of 2nd to 15th harmonics order.

g. It should be possible to use filter for single harmonic elimination

h. PF compensation should be leading as well as lagging

- Following features are essential requirements for the point of reliability
  a. For capacities from 100 Amp onwards the filter design should adapt modular construction
  b. The display should be Touch screen SVGA display with true RMS readout & FFT analysis. The waveform should be visible on the display.
  c. High grade cooling fans shall be used.
  d. In case of future repair requirements, the same shall be done through card level replacement and not the whole module

- Electrical Ratings:
  a. System Voltage: 400V AC ± 10%, 3ph 4 Wire/3 wire
  b. Line voltage tolerance: ±10%
  c. System Frequency: 50 Hz
  d. Frequency tolerance: 50 Hz ± 5%
  e. Multiple filter units for parallel connection may be used to achieve total current requirements for combined power factor correction and harmonic mitigation.
  f. Current transformers shall be with Class 1 or better with 15VA rating.
  g. Flexibility to select CT ratio shall be available.
  h. Remote indication contacts: 1No. potential free contact.
  j. Should comply with IEC/IEEE 62040 – 2 category C3

- Basic Product Requirements
  The active harmonic filter shall meet the following basic requirements:-

  1. Active filters shall include input surge suppression.

  2. Active filters shall include forced air cooling system.

  3. Active filter shall be able to connect in both open loop and closed loop configuration

  4. Active filter should have a HMI touch screen display having the functionality of a power analyzer and should display Load side, supply side and filter parameters as mentioned below-

    a. Voltage

    b. Current

    c. Power factor

    d. Filter Temperature

    e. Voltage and current waveforms

    f. Voltage and current Harmonic spectrum
g. Active, Reactive & Apparent Power
h. Alarm indications & log details

5. Active filter shall be isolated from the power supply when powered “off”.
6. IGBT modules shall be self-protected for maximum reliability.
7. Each power module shall have its own independent set of fuses.
8. The response time shall be at least 1 ms and the correction time shall be 20 to 40 ms.
9. AHF shall have inbuild logic to avoid over-loading without tripping.

- Construction:
  1. Constructed on metal panel with minimum IP 42.
  2. Filter shall be suitable for operation within an ambient temperature between 0°C and 50°C.
  3. Shall be able to work with higher temperature with automatic de-rating.
  4. Storage temperature shall be from 0°C to 70°C.
  5. Active filters shall be suitable for operation in relative humidity up to 95% non-condensing.

16.10.3. SECTION 2 - APFC Panels with passive filters:

Automatic Power Factor Correction panel shall be totally enclosed, metal clad, sheet steel fabricated, fixed feeder type, dust and vermin-proof, free standing, floor mounting type. The enclosure shall be pre-treated as per 11 tanks process and finished with powder coating of shade RAL 7032. The panel shall be factory build to ensure:

- Proper thermal design, by providing louvers and fans in appropriate location,
- Accurate selection of switchgear, capacitors-reactors and others in the panel.
- Safety during operation, inspection and maintenance

16.10.4. BASIC Design Specifications

An automatic power factor correction relay, microprocessor based, with arrangement for sensing the power factor of the inductive load (maximum 14 channels) and giving signal to the feeders of power capacitors as per the setting of P.F. and electronic circuit to ensure that once a capacitor gets cut off, it is not put on at least for a minute. The relay should automatically manage capacitor banks according to the reactive power required to correct the power factor of the load to the power factor set on the relay. The capacitors must be turned “on” and “off” to correct the power factor of the load to the power factor set on the relay. The relay should have automatic and manual mode of operation with an LED to indicate the operating mode. The auto / manual function makes it possible to turn the capacitor banks “on” and “off” manually regardless of the line value measured.

<table>
<thead>
<tr>
<th>Rated System Voltage</th>
<th>440 V / 415 V / 380 V / 400 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Short Circuit Rating</td>
<td>&gt; 30 kA</td>
</tr>
<tr>
<td>Altitude</td>
<td>1000 m</td>
</tr>
<tr>
<td>Duty</td>
<td>Continuous</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>-5° C to 50° C</td>
</tr>
</tbody>
</table>
### Construction of AIIMS, Guwahati (Assam) - Vol:V - Tech Specs

#### Power Supply
- Three phase, four line

#### Relay current input signal
- -- / 5A, from CT on line

#### Enclosures
- The load bearing structure is made of 2 mm sheet steel
- The front door and partition are made of 1.6 mm sheet steel
- The internal switchgear components are accessible on opening the front door and Capacitors & Reactors shall be accessed through back door
- Ingress protection - IP42

#### Installation
- Indoor, wall mounted (up to 100 kVAr), floor mounted (100 kVAr and above) in a well-ventilated, non-dusty environment, cable entry from bottom

#### Control
- Auto + Manual

#### Incomer
- 3 Pole MCCBs up to 630 A (400 kVAr) , 3 Pole ACBs above 630 A (above 400kVAr)

Other important features required are:
- Various system parameter display on APFC Relay
- Fully automatic / manual setup and operation
- Minimal joining in all the connections to ensure better reliability and lower losses.
- Use of special connecting cables suitable for high temperature withstands.
- Flush mounted meter to indicate line voltage and current.

**16.10.5. 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:**
- 3 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

**16.10.6. DETUNED FILTER**

- Detuned harmonic filter reactors shall be used along with power capacitors to mitigate harmonics amplification and to avoid electrical resonance in LV electrical
networks.

- The complete unit shall be impregnated under vacuum and over-pressure in impregnation resin. The insulation shall be Class H.

- 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.

- The permitted tolerance of inductance is ± 3% of rated inductance value.

- 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.

- The limit of linearity of inductance of the filter reactor is: 1.8*In with L=0.95*LN.

- 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.

- Power loss in each reactor shall be less than 5 W/kVar

- Each reactor shall have routine test certificate for the above tests.

16.10.7. Contactor

- All contactors shall be AC6B 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. Contactors 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

- Contactors should be with surge suppressor

- Operation voltage up to 690V

- Insulation voltage 1 kV

- Rated impulse withstand up to 8 kV

16.10.8. 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 RS485 communication protocol.

16.10.9. 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.

16.10.10. TESTS AT MANUFACTURER’S WORKS:

All routine and type tests as per IS:2834 relevant to capacitor bank s 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.

16.10.11. 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

17. EARTHING & LIGHTENING 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 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. earthing of all sus. The body
Earthing for transformers, DG, HV & MV panels shall be done separately (2 Nos. for each equipment) and shall also made a common earth bus network.

Like for a single transformer, the total number of earth electrodes shall be 4 (2 for neutral and 2 for connection to a common earth bus for body earthing).

17.1. ELECTRODES

The earth electrodes shall be as per CPWD General Specifications for Electrical Works (Part I-Internal), 2013.

17.2. 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.

17.3. WATERING ARRANGEMENT

Method of watering arrangement shall comply with CPWD general specifications.

17.4. 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.

17.5. 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 sufficiently 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.

17.6. 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.

17.7. LIGHTNING 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. However, all earth pits shall be GI or copper Plate electrodes. Finial shall be of copper material and for earth grid/mes & downcomers, required size Copper strip/equivalent size G.I. strip shall be used.

18. 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:

(i) 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.

(ii) 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.

(iii) 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.

(iv) 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.

(v) Fire Buckets
   Fire buckets conforming to IS 2546: 1974 shall be installed with the suitable stand for storage of water and sand.

(vi) Tool Box
   A Standard tool box containing necessary tools required for operation and maintenance shall be provided in the sub-station.

(vii) Caution Board
   Necessary number of caution boards such as “Man on Line” ‘Don't Switch on’ etc. shall be available in the sub-station.

(viii) 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

19. 11/0.433 KV DRY TYPE TRANSFORMER (ON LOAD TAP CHANGER TYPE)

19.1. 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 Table7.1 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.

19.2. CODES AND STANDARD

Transformers shall comply with the latest edition of Indian Standards No. IS 2026 Part I to Part V (Power Transformer) and IS-11171 for Dry Type Transformer. In case the Provision of Indian Standards are not directly applicable to dry type Transformer, the provision of latest IEC-60726 and any other relevant IEC shall apply. Latest Stadards as applicable shall be followed the Insulating materials, Bushing, Installation and Maintenance of the Transformer.

19.3. 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 Temperature</td>
<td>50 deg. C</td>
</tr>
<tr>
<td>Minimum Ambient Temperature</td>
<td>-5 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>

19.4. 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.

19.5. 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 vaccum 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 arrangement. The Transformer shall be free of partial discharges at least up to 1.1 times the rated voltage.

The winding shall not absorb moisture under the worst tropical conditions. The collection of moisture and dust over the winding shall not in any way affect the insulation strength of the winding.

19.6. 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 tightened 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.

19.7. INSULATION
Interturn and inter coil insulation shall be designed such that dielectric stress is uniformly distributed throughout the winding under all operating conditions. The winding shall be provided with Class ‘F’ Insulation.

19.8. TEMPERATURE RISE

The temperature rise of the winding shall not exceed 90 deg C 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.

19.9. 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.

19.10. VECTOR GROUP:

Transformer shall have the vector group of Dyn 11.

19.11. IMPEDANCE

The desired impedance shall be as mentioned in the IS:11171 and ECBC norms.

19.12. 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.

19.13. 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.

19.14. COOLING

The Transformer shall be designed for natural cooling (AN) or forced cooling as required for smooth continuous functioning at site.

19.15. 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 44 for outdoor installations. The sheet steel thickness of enclosure shall be minimum 2mm.

19.16. 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 with bottom entry provision.

All cable end boxes shall have bore holes to match the opening for each cable specified and shown in the single line diagram.

19.17. EARTHING

Two main earthing terminals shall be connected to the terminals provided for transformer.

19.18. 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.

• Nos. Plan bi-directional rollers.

• Inspection windows shall be provided in the cover.

• Lifting lugs for both the transformer and core shall be provided.

19.19. 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 regrious 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.

19.20. 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.
19.21. **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.

19.22. **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

19.23. **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

19.24. **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.

19.25. **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).

**19.26. 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.

**20. INTERNAL ELECTRIFICATION OF BUILDING**

**20.1. 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. 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

Wherever these specifications calls for a higher standard of material and or workmanship than those required by any of the above mentions regulations and specification then the specification here under shall take precedence over the said regulations and standards.

Following Light/power point Shall be provided as minimum or as per approved shop drawings in following areas and as directed by Engineer In-Charge

**Consultation Room:**
- 6/16 A Raw Power points- 2 nos.
- 6/16 A UPS power points – 2 Nos.
- Data points- 1 Nos.
- Telephone Points – 1 Nos.
- Light fittings as per required Lux level (NBC-2016, ECBC)

**General Wards with Each Bed:**
- 6/16 A Raw Power points- 2 nos.
- 6/16 A UPS power points – 2 Nos.
- Light fittings as per required Lux level (NBC- 2016, ECBC)
- Foot Light

ICU/ICCU with Each Bed-
- 6/16 A Raw Power points- 4 nos.
- 6/16 A UPS power points – 4 Nos.
- Light fittings as per required Lux level (NBC-2016, ECBC)
- Bed Head Light (Up & Down)

Confrence Room-
- 6/16 A Raw Power points- 4 nos.
- 6/16 A UPS power points – 2 Nos. shared in Two seats (in Pop up box)
- HDMI Port – 1 Nos. shared between Two seats (in Pop up box)
- Data points – 2 Nos. shared between Two seats or Wifi connectivity
- Dimmer Lights as per requirement
- Light fittings as per required Lux level (NBC-2016, ECBC)
- Data & UPS Power points for Projector / Monitor/PC

20.2. 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, ‘C’ curve 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. No isolator shall be used in distribution board & panels unless stated otherwise. 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 manufactures 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.

20.3. METALLIC CONDUIT WIRING SYSTEM.
20.3.1. 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.

20.3.2. 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.

20.3.3. 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.

20.3.4. 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.

20.3.5. 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.

20.3.6. 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.

20.3.7. 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
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.

20.3.8. 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.

20.3.9. 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.

20.4. NON-METALLIC CONDUIT WIRING SYSTEM

20.4.1. 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.

20.4.2. 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.

20.4.3. Materials

a) 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 conduits shall be as per CPWD specification.
- 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.

b) 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.

c) 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.

20.4.4. Installation

a) 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/fitting 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.

- Conduit joints after preparation 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.

### b) 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.

#### 20.4.5. 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).

#### 20.5. 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 staircases 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. At least 10% Light fixtures shall be provided and operated with UPS supply with switches fed from UPS Distribution Boards.

20.5.1. 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.

20.5.2. 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.

20.6. 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 FRLS copper wire for RYB phase wire respectively and black colour PVC insulated FRLS 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>Conduit size</th>
<th>20mm</th>
<th>25mm</th>
<th>32mm</th>
<th>40mm</th>
<th>50mm</th>
<th>60mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire size in sq.mm.</td>
<td>S B</td>
<td>S B</td>
<td>S B</td>
<td>S B</td>
<td>S B</td>
<td>S B</td>
</tr>
<tr>
<td>1.50</td>
<td>7 5</td>
<td>12 10</td>
<td>20 14</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>2.50</td>
<td>6 5</td>
<td>10 8</td>
<td>18 12</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>4</td>
<td>4 3</td>
<td>7 6</td>
<td>12 10</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>6</td>
<td>3 2</td>
<td>6 5</td>
<td>10 8</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>10</td>
<td>2 -</td>
<td>4 3</td>
<td>6 5</td>
<td>8 6</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>16</td>
<td>- -</td>
<td>2 -</td>
<td>4 3</td>
<td>7 6</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>25</td>
<td>- -</td>
<td>- -</td>
<td>3 2</td>
<td>5 4</td>
<td>8 6</td>
<td>9 7</td>
</tr>
<tr>
<td>35</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>3 2</td>
<td>6 5</td>
<td>8 6</td>
</tr>
<tr>
<td>50</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>5 3</td>
<td>6 5</td>
</tr>
<tr>
<td>70</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>4 3</td>
</tr>
</tbody>
</table>

NOTE:
1. The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.
2. The columns headed ‘S’ apply to runs of conduits which have distance not exceeding 4.25m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns headed ‘B’ apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.
3. Conduit sizes are the nominal external diameters.

20.6.1. 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.

20.6.2. LOAD BALANCING

Balancing of circuits in three-phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

20.6.3. 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.

20.6.4. CLASSIFICATION OF POINTS.

a. General

Classification of Point wiring shall be as per CPWD specification for Electrical Works (Part-I- Internal) 2013.

b. Point Wiring (Modular)

i. 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/MCB. 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.

c. **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).

---

20.6.5. **Circuit and Submain Wiring**

a. **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.

b. **Submain Wiring**

Submain wiring shall mean the wiring from one main/distribution switchboard to another.

---

20.6.6. **Power Plug Wiring**
a. **6A Plug Wiring**
Wiring for all 6 A Socket Outlets shall be done with 2 X 2.5 sq mm PVC insulated FRLS 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.

b. **16A Power Plug Wiring**
Wiring for all 16 A Socket Outlets/Geyser point shall be done with 2X4 sq mm PVC insulated FRLS 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).

c. **Wiring for 20A Metal Clad Socket Outlets**
Wiring for all 20A Metal Clad Socket Outlets shall be done with 2X6 sq mm PVC insulated FRLS copper wire in suitable size MS Conduit (including supplying and fixing MS Conduit) along with the earth wire directly from the MCB-Distribution Board. 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.

20.6.7. **CONDUCTOR SIZE.**

Wiring shall be carried out with following sizes of PVC insulated FRLS multiple 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 32A MCB- 6 Sqmm

20.7. **LIGHTING FIXTURE AND FANS**

20.7.1. **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, ballasts, 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.

20.7.2. 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.

20.7.3. LED Light Fixtures -GENERAL

LED Lighting fixtures shall provide luminous efficacy of more than 100 Lumens/ Watt, including Driver & accessories. LED Light Fixtures shall have inbuilt harmonic mechanism to mitigate harmonics up to less than 10%.

20.7.4. 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.

20.7.5. 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.

20.7.6. 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 with stepped control. 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.

20.7.7. 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.

20.8. TELEPHONE SYSTEM

20.8.1. Telephone point wiring

(a) The point wiring shall be carried out with four pair Cat6a LAN cable, in the PVC conduit Minimum Dia. of Conduit for Internal/External Telephone Wiring - 20mm.

If more than one telephone point has to be provided at one point, multi CAT6a Cable shall be used in suitable size of conduit.

(b) The point shall commence from the main telephone Rack and would terminate at outlet box of point.

(c) Fixing of conduit, conduit accessories draw out boxes and outlet box etc. in concealed/surface conduit works as that of wiring for light fixtures shall be applicable for telephone wiring conduit system also.

(d) Joint in telephone wiring (between Rack and outlet box of point) shall not be allowed and the contractor should bear the wastages of wire if resulted due to this special requirement of telephone system.

(e) External/Internal telephone and intercom wiring can be drawn in the same conduit, provided after drawing wires, 50% of conduit cross sectional area is free. However, independent armoured CAT 6A wire shall be used for external intercom.

(f) To identify telephone wire/cable, PVC indication numbers shall be put on both ends of wire/cable just before termination.

20.8.2. Telephone Rack

The Telephone CAT6A cables can also be terminated in the existing LAN Rack of suitable space.

20.8.3. Telephone Instruments:

Telephone Instruments shall be provided at various locations in the Institutional and Residential as directed by Engineer-In-Charge.

21. MASTER ANTENNA TELEVISION SYSTEM

The system shall comprise the reception and distribution of VHF Broadcast signals through one Master Head Antenna through suitable cable network, to each individual outlet. The equipment shall be: Master Antenna, Master Head Antenna Pre-Amplifier (if required), Broad Band (VHF-UHF) Amplifier/Mixer, Splitters and Directional Coupler, Wall Connectors/Terminations of Antenna Cables and Interconnecting low-loss MATV co-axial cables.

MATV systems allow multiple receivers (TV & FM) to receive signals from a single (Master) antenna, as opposed to individual antennas for each receiver. MATV systems are separated into two portions, the ‘Head End’ and the ‘Distribution System’.

21.1. Master Antenna in MATV System

The Master Antenna shall be selected, as per as site location and requirement. The antenna shall be fixed on to the highest point of the building and shall be orientated for reception of maximum signal level. Construction of Master antenna shall be Outdoor type & weather protected. Frequency should be either VHF or UHF as required, and impedance to be 75 ohms.

21.2. Antenna Pre-Amplifier
The Master Pre-Amplifier shall be mounted on the Antenna Master. The Master Pre-Amplifier shall be of low noise, offering a gain of 15-25 dB or as required to boost the incoming signal to feed free signals to the main amplifier. Its construction shall be outdoor, totally enclosed type, frequency to be 40 MHz to 230 MHz / 470-890 MHz, Input Impedance shall be 75 ohms, output impedance shall be 75 ohms, gain should be between 15-25 dB, noise figures of 3 dB or similar, operating temp between -10 Degree C to 45 Degree C and electrical power supply should be 230 V, 50 HZ, AC.

21.3. Broad Band Amplifier / Mixer for MATV System

The Board Band Amplifier / Mixer shall be suitable for amplification of VHF / UHF signal strength sufficiently, to enable further distribution. The gain shall be adjustable over 40 dB, so that distribution voltage can be adjusted for week signals as well as for strong signals. The amplifier shall have high noise rejection characteristics. The amplifier / mixer shall have common output with two separate inputs for VHF and UHF signals. Construction of broad band amplifier / mixer shall be indoor type, aluminium housing, input frequency should be separately given for both VHF and UHF, output to be single common, frequency bandwidth for VHF 40-230 MHz and UHF 470-860 MHz. Signal gain shall be 35 dB (VHF) and 40 dB (UHF), input Impedance to be 75 ohms, output impedance to 75 ohms, noise level shall be 3 dB for VHF and 4 dB UHF; operating temp to be -10 Degree C to 45 Degree C.

21.4. Splitters for MATV System

The splitters in Master Antenna System shall be for 2 way and 4 way output as required. The incoming signal shall be split into 2 or 4 equal signal outputs. The attenuation and mismatch shall be minimum. Construction of Splitters for MATV System to be indoor, totally enclosed type. It shall have 2/4 ways, 4/8 dB VHF insertion loss, 75 ohms impedance and F type cable termination.

21.5. Directional Couplers for MATV System

Directional couplers to be constructed suitable for indoor type, totally enclosed. No. of outputs to be 1/2, less than 3 dB insertion loss, 75 ohms input impedance, 75 ohms, output impedance, branch loss to be 12 dB for VHF and 14 dB for UHF and F type cable termination.

21.6. Wall Connectors of MATV System

The wall connectors shall be suitable for termination of TV Antenna co-axial plug-connectors, in positions shown in drawings. The outlets shall be recessed in walls, with the connectors fixed onto acrylic sheets.

21.7. MATV CABLE

The MATV cable shall be Co-axial, solid copper conductor PE insulated, shielded with fine tinned copper braid and protected with PVC Sheath. It shall be laid in the PVC conduit.

21.8. Specification of the devices shall be as following:-

<table>
<thead>
<tr>
<th>MATV Cable</th>
<th>Conductor size (mm)</th>
<th>AWG</th>
<th>Cond. Type</th>
<th>Shield Type</th>
<th>Nominal O.D. (mm)</th>
<th>Insulation &amp; Core O.D. (mm)</th>
<th>Velocity of Propagation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RG 59 Dual Shield MATV Cable</td>
<td>0.813</td>
<td>20</td>
<td>Solid BCCS</td>
<td>60% Aluminium Braids</td>
<td>6.02</td>
<td>3.66</td>
<td>83</td>
</tr>
</tbody>
</table>
RG6 Dual & Tri Shield MATV Cable  1.02  18  Solid BCCS  60% Aluminium Braids  6.86  4.57  85

RG6 Quad Shield MATV Cable  1.02  18  Solid BCCS  60% & 40% Aluminium Braids  7.57  4.57  85

RG11 Quad Shield MATV Cable  1.63  14  Solid BCCS  60% & 40% Aluminium Braids  11.34  7.1  83

24dB Wide-band VHF/UHF Amplifier

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Maximum Gain(dB)</th>
<th>Inputs</th>
<th>Noise Figure</th>
<th>Gain Figure</th>
<th>Current (mA)</th>
<th>FM Trap Option</th>
<th>Pager Option</th>
<th>Output Figure (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHF 44-470</td>
<td>18</td>
<td>1</td>
<td>&lt;3</td>
<td>Tilt 14-10</td>
<td>80</td>
<td>NO</td>
<td>NO</td>
<td>105</td>
</tr>
<tr>
<td>UHF 470-860</td>
<td>24 fixed</td>
<td>comb</td>
<td>&lt;3</td>
<td>NO</td>
<td>80</td>
<td>N/A</td>
<td>N/A</td>
<td>105</td>
</tr>
</tbody>
</table>

34dB Wide-band VHF/UHF Amplifier

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Maximum Gain(dB)</th>
<th>Inputs</th>
<th>Noise Figure</th>
<th>Gain Figure</th>
<th>Current (mA)</th>
<th>FM Trap Option</th>
<th>Pager Option</th>
<th>Output Figure (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHF 44-230</td>
<td>20-27</td>
<td>1,2</td>
<td>&lt;3</td>
<td>Tilt 12-10</td>
<td>90</td>
<td>-24</td>
<td>-24</td>
<td>108</td>
</tr>
<tr>
<td>UHF 520-860</td>
<td>34</td>
<td>comb</td>
<td>&lt;2.5</td>
<td>10</td>
<td>90</td>
<td>N/A</td>
<td>N/A</td>
<td>108</td>
</tr>
</tbody>
</table>

38dB Wide-band VHF/UHF Amplifier

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Maximum Gain (dB)</th>
<th>Inputs</th>
<th>Noise Figure</th>
<th>Gain</th>
<th>Current (mA)</th>
<th>FM Trap Option</th>
<th>Pager Option</th>
<th>Output Figure (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHF 44-230</td>
<td>20-28</td>
<td>1,2</td>
<td>&lt;3</td>
<td>10</td>
<td>100</td>
<td>33 (Freq.Adj)</td>
<td>25</td>
<td>110</td>
</tr>
<tr>
<td>UHF 470-860</td>
<td>24 fixed</td>
<td>comb</td>
<td>&lt;2.5</td>
<td>10</td>
<td>100</td>
<td>N/A</td>
<td>N/A</td>
<td>110</td>
</tr>
</tbody>
</table>

22. UPS SYSTEM

22.1. Quality power Supply
The UPS shall be ON-LINE double conversion with filter & isolation transformer, 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.

22.2. 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 pr standard EN 50171.

- **The UPS shall have Expandable feature**: The UPS shall have expandable feature to increase power availability or redundancy. For the expandability there shall be “Hot System Expansion” feature, the additional unit can be connected in parallel while the other units are on-line and supplying regular power to the load.

22.3. 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/Communication 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.

22.4. 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’s 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.

22.5. UPS & its features:

a. The input requirements of the UPS are as follows:

- Voltage: 415 V, Three-phase + Neutral
- Voltage tolerance: ± 20%
- Frequency: 45-65 Hz
- Current distortion: <4% with active filter
- Power factor: 0.99 with active filter

b. The Bypass of the UPS are as follows:

- Rated voltage: 415 V, Three-phase + N
- Phases number: 3 + N
- Voltage tolerance: ± 15%
- Rated frequency: 50 Hz
- Frequency tolerance: ± 2%
- By-pass: Static and manual for maintenance
- Transfer time: Nil

c. 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

d. The Output of UPS are as follows:

- Rated power: As per General arrangement/DBR
- Active power: As per General arrangement/DBR
- Phases number: 3 + N
- Waveform: Sinewave
- Rated voltage: 415 V
- Frequency: 50 Hz
- Dynamic stability: ± 5%
- Static stability: ± 1% 00
- Crest factor: 3 : 1
- Overload: 110% for 10 min, 125% for 5 min

e. The System of UPS is as follows:

- AC/AC efficiency: 92% in On-line mode
- Noise: 50-56 db at 1 M distance
- Operating temperature: -2°C to 45°C
- Relative humidity: 95% non-condensing
Remote controls : EPO & Bypass
Remote signals : volt free contacts
Protection degree : IP20
Communication : Double RS232/C + slot for SNMP Adapter

22.6. The Codes & Standard for UPS are as follows:
1. Safety EN 62040-1
2. EMC IEC 62040-2
3. EN 50091-2 lev. A
4. Directives 73/23, 93/68, 89/336 EEC
5. EN 62040-3.

All LV equipments installed in Data/IT Server Room, Audio-visual media room, IPABX Room, CCTV System, BMS system, SCADA System, Fire Alarm System, PA System, Fire Officer Control Room & Security room etc. shall be fed from UPS supply only.

23. EXTERNAL STREET LIGHTING SYSTEM:

23.1. 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.

23.2. GENERAL SPECIFICATION FOR HIGH MAST:

i. SCOPE:
This specification covers the technical requirements of design, manufacture, testing at manufacturer’s works, packing, forwarding of High Mast. High Mast lighting shall be provided as per specification Type-I, unless stated otherwise, as per direction of Engineer-In-Charge.

ii. APPLICATION STANDARDS:
The equipment covered by this specification shall unless otherwise stated, be designed, manufactured and tested in accordance with the latest editions of the following Indian, International standards and shall confirm to the regulations of the local authorities.

- IS 875 (Part III) 1987 (Code and practices for design loads for structures)
- IS 2062 : 2006 (Hot rolled low, medium and high Tensile structural steel)
- BSEN 10025/DIN 17100 (Grades of MS Plates)
- BSEN 60529 (Degree of provided by Enclosures- IP code)
- BS 5135 / AWS (Welding)
• BS EN ISO 1461 : 1999 (Galvanizing)
• BS EN 5649-4: 1982 (Lighting columns, Recommendations for surface protection of metal lighting columns)
• TR No. 7 1996 of ILE, UK (Specifications of Masts and foundations)

iii. GENERAL CONSTRUCTIONS:
The High Mast shall be designed to withstand the maximum wind speed as per IS: 875. The top loading, i.e. the weight and the area of luminaries are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BS: 5649 Part VI – 1982. The Mast shall be designed using limit state principle. The limit states to be considered are: (i) Ultimate and (ii) Serviceability; based on a design wind speed with a return period of 25 years. The total Height of the High Mast, with luminaries mounting carriage cum head frame and luminaries installed shall be measured as the vertical distance between the base flange plate and the plane in which the lamps lie in their operating position.

a. STRUCTURE:
The High Mast shall be of continuously tapered, polygonal cross section; ranging from 8 to 20 sided, and shall be based on proven In-Tension design conforming to the standards referred above, to give an assured performance and reliable service. The structure shall be suitable for wind loading as per IS 875 part 3 1987.

b. CONSTRUCTION:
The High Mast shall be manufactured using steel plates, conforming to BS EN 10-025. The high mast shall be manufactured in two sections for 12.5 meters, 16metres and 20metres. In case of 25 meters and 30 meters high mast shall be manufactured in three sections. Each mast section shall be fabricated out of single plate duly folded and welded. The Mast shaft shall have polygonal cross section and shall be continuously tapered with single/Double longitudinal welding. There shall not be any circumferential welding and pole shafts with more than two longitudinal weld shall not be acceptable. The welding of pole shaft shall be done by Submerged Arc Welding (SAW) process. No site welding and bolted joints shall be done on the mast. The minimum overlap distance shall be 1.5 times the diameter at penetration. The minimum top diameter and bottom diameter shall be as specified in data sheets and plate thickness shall be as per the structural design requirements. The calculation for civil design and foundation details shall be submitted by the EPC Contractor for approval of Engineer-In-Charge. The mast shall be provided with fully penetrated flange, which shall be free from any lamination or incursion. The welded connection of the base flange shall be fully developed to the strength of the entire section. The base flange shall be provided with supplementary gussets between the bolt-holes to ensure elimination of helical stress concentration.

c. GALVANIZING:
For environmental protection of the mast the entire fabricated mast shall be hot dip galvanized internally and externally as per BS EN ISO 1461 standards with an average coating thickness of minimum 85 micron. The galvanizing shall be done in single dipping only. Double dip-galvanized shafts with overlapping are not acceptable. Further, no post galvanizing painting, touch-up or rectification shall be allowed.

d. DOOR OPENING:
All adequate door opening shall be provided as per the GTP such that the minimum distance from the mast flange plate to the bottom of the door opening shall twice the width of the door opening. The door shall be flushed with the exterior surface. The door
opening shall be such that it permits clear access to equipment like winches, cables, plug and socket, etc. and also facilitate easy removal of the winch. The door opening shall be complete with a close fitting, vandal resistant, weatherproof door, provided with heavy duty double internal lock with special paddle key. The minimum radius at the corners of openings shall be 20mm. The door opening shall be carefully designed and reinforced with welded steel section, so that the mast section at the base shall be unaffected and undue buckling of the cut portion is prevented.

e. **DYNAMIC LOADING FOR THE MAST:**

The mast structure shall be suitable to sustain an assumed maximum reaction arising from a wind speed as per IS: 875 (Part-III) 1987 (three second gust) and shall be measured at a height of 10 meters above ground level. The design life of the mast shall be minimum of 25 years.

f. **LANTERN CARRIAGE:**

i. **FABRICATION:**

A fabricated raising and lowering type Lantern Carriage cum head frame shall be provided at the top of high mast shaft properly secured for fixing and holding the flood light fittings and control gear boxes. The Lantern Carriage shall be of special design and shall be of steel channel construction. The Lantern Carriage shall be so designed and fabricated to hold the required number of flood light fittings and the control gear boxes, and also have a perfect self balance. The Lantern Carriage shall be fabricated in two/three halves and joined by bolted flanges with stainless steel bolts and nylon type stainless steel nuts to enable easy installation or removal from the erected mast. The inner lining of the carriage shall be provided with protective PVC arrangement, so that no damage is caused to the surface of the mast during the raising and lowering operation of the carriage.

The entire Lantern Carriage shall be hot dip galvanized after fabrication. The lantern carriage shall be fabricated out of M.S. channel with suitable reinforcements. Also an certificate to this effect quoting safe working load shall be supplied with each carriage. The carriage shall carry a permanently attached label stating the safe working load. Both the Mast Shaft and Luminaries Mounting Carriage shall be sourced from one manufacturer only so as to ensure compatibility and overall finish of the material.

ii. **JUNCTION BOX:**

Weather proof junction box, made of Cast Aluminum shall be provided on the Carriage Assembly as required, from which the inter-connections to the designed number of the flood light luminaries and associated control gears fixed on the carriage shall be made.

iii. **RAISING AND LOWERING MECHANISM:**

For the installation and maintenance of the luminaries and lamps, it will be necessary to lower and raise the Lantern Carriage Assembly. To enable this, a suitable Winch Arrangement shall be provided, with the winch fixed at the base of the mast and the specially designed head frame assembly at the top.

iv. **WINCH:**

The winch shall be of completely self sustaining type, without the need for brake shoe, springs or clutches. Each driving spindle of the winch shall be positively locked when not in use by gravity activated PAWLS. The capacity, operating speed, safe working load, recommended lubrication and serial number of the winch shall be clearly marked on each winch. The gear ratio of the winch shall be calculated considering minimum working load not less than 750 kg. The winch shall be self-lubricating type by means of an oil bath and
the oil shall be readily available grades of reputed producers. The winch drums shall be grooved to ensure perfect seat for stable and tidy rope lay, with no chances of rope slippage. It shall be possible to operate the winch manually by a suitable handle and electrically by an external power tool also. It shall be possible to remove the double drum after dismantling, through the door opening provided at the base of the mast. A test certificate shall be furnished by the Contractor from the original equipment manufacturer, for each winch in support of the maximum load operated by the winch.

g. STAINLESS STEEL WIRE ROPES:
The suspension system shall essentially be without any intermediate joint and shall consist of only non-corrodible stainless steel of AISI 316 grade. The stainless steel wire ropes shall be of marine grade 7/19 construction, the central core being of the same material. The overall diameter of the rope shall not be less than 5mm for 12mtr. High mast and 6mm for 16mtr. And 20mtr. High mast. The breaking load of each rope shall not be less than 2350 kg giving a factor of safety of over 5 for the system at full load as per the TR-7 referred to in the beginning of this specification. The end constructions of ropes by compression splices. Continuous lengths of stainless steel wire ropes shall be used in the system and no intermediate joints are acceptable in view of the required safety. No intermediate joints/ terminations, either bolted or else, shall be provided on the wire ropes between winch and lantern carriage. The design of the whole suspension system shall be such that the wire ropes can be removed and replaced from ground level without the necessity of lowering the mast or use of special equipment.

h. ELECTRICAL SYSTEM, CABLE AND CABLE CONNECTIONS:
The control panel at the bottom of the mast shall have facility for terminating up to 1.1kV, 4C x 25 sq. mm, Aluminium conductor, armoured, XLPE incoming cable. The outgoing from this panel shall be the trailing cable, which is terminated at the weather proof junction box provided at the top. This cable shall be minimum 6 cores, 2.5 sq. mm, 1100V, electrolytic grade, EPR insulated, copper conductor and PCP sheathed cable to get flexibility and endurance. The connections from the top junction box to the individual luminaries shall be made by using 3 core 4 sq.mm flexible PVC cables of reputed make. The cable shall run via metal ducts or tubes provided in luminary’s carriage up to individual luminaries and control gear units. All steel conduits shall be of heavy gauge welded type with hot dipped galvanized finish.

i. LIGHTNING SPIKE:
One number heavy duty hot dip galvanized lightning spike shall be provided for each mast. The lightning spike shall be minimum 1.2 M in length (except for 12.5m where it will be 0.6m) and shall be provided at the centre of the head frame. It shall be bolted solidly to the head frame to get a direct conducting path to the earth through the mast. The lightning spike shall not be provided on the lantern carriage under any circumstances in view of safety of the system.

j. AVIATION OBSTRUCTION LIGHTS:
Provision for mounting LED type aviation obstruction lights of reliable design shall be provided on top of each mast for 20m high masts only.

<table>
<thead>
<tr>
<th>12.5 METER HEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S.No.</strong></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>1.1</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>1.2</td>
</tr>
<tr>
<td>1.3</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>3.1</td>
</tr>
<tr>
<td>3.2</td>
</tr>
<tr>
<td>3.3</td>
</tr>
<tr>
<td>3.4</td>
</tr>
<tr>
<td>3.6</td>
</tr>
<tr>
<td>3.7</td>
</tr>
<tr>
<td>3.8</td>
</tr>
<tr>
<td>3.9</td>
</tr>
<tr>
<td>3.10</td>
</tr>
<tr>
<td>3.11</td>
</tr>
<tr>
<td>3.12</td>
</tr>
<tr>
<td>3.13</td>
</tr>
<tr>
<td>3.14</td>
</tr>
<tr>
<td>3.15</td>
</tr>
<tr>
<td>3.16</td>
</tr>
<tr>
<td>3.17</td>
</tr>
<tr>
<td>3.18</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>4.1</td>
</tr>
<tr>
<td>4.2</td>
</tr>
<tr>
<td>4.3</td>
</tr>
<tr>
<td>4.4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>5.1</td>
</tr>
<tr>
<td>5.2</td>
</tr>
<tr>
<td>5.3</td>
</tr>
<tr>
<td>5.4</td>
</tr>
<tr>
<td>5.5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>8</td>
</tr>
</tbody>
</table>
### 9 Stainless Steel wires diameter

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6mm</td>
<td></td>
</tr>
</tbody>
</table>

### 9.1 Number of Ropes

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Two [6mm size]</td>
<td></td>
</tr>
</tbody>
</table>

### 9.2 C/disc to D/d. winch

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Three [6mm size]</td>
<td></td>
</tr>
</tbody>
</table>

### 9.3 C/disc to Lantern Ring

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Provided.</td>
<td></td>
</tr>
</tbody>
</table>

### 9.4 Thimbles & Terminals

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Provided.</td>
<td></td>
</tr>
</tbody>
</table>

### 9.5 Factor Of Safety

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;5</td>
<td></td>
</tr>
</tbody>
</table>

### 10 POWER TOOL

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bharat Bijlee/ Remi</td>
<td></td>
</tr>
</tbody>
</table>

### 10.1 Model

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>415v,50c/s;3-ph</td>
<td></td>
</tr>
</tbody>
</table>

### 10.2 Input Supply

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.75 kW</td>
<td></td>
</tr>
</tbody>
</table>

### 10.3 WATTAGE

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td></td>
</tr>
</tbody>
</table>

### 10.4 Num. Of Speeds

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Reversible</td>
<td></td>
</tr>
</tbody>
</table>

### 10.5 Reversible/Non-reversible

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1400 Rpm</td>
<td></td>
</tr>
</tbody>
</table>

### 10.6 Operating Speed

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lightning Arrestor [0.6 m Length]</td>
<td></td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>will be provided</td>
<td></td>
</tr>
</tbody>
</table>

### 10.7 Lightning Arrestor

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Aviation Obstruction light</td>
<td></td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Provision for mounting will be provided</td>
<td></td>
</tr>
</tbody>
</table>

### 16 METER HEIGHT

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>High mast Height[mtrs] incl.Luminaires Carriage</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Material Construction</td>
<td>BSEN100025 or</td>
<td>BSEN100025 or</td>
<td>BSEN100025 or</td>
<td>BSEN100025 or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eqiv</td>
<td>Eqiv</td>
<td>Eqiv</td>
<td>Eqiv</td>
</tr>
<tr>
<td>1.2</td>
<td>Welding</td>
<td>As per IS</td>
<td>As per IS</td>
<td>As per IS</td>
<td>As per IS</td>
</tr>
<tr>
<td>1.3</td>
<td>No. Of Sides</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>WIND LOAD DATA taken for this project</td>
<td>as per IS 875</td>
<td>as per IS 875</td>
<td>as per IS 875</td>
<td>as per IS 875</td>
</tr>
<tr>
<td>3</td>
<td>Mast Section Details</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Top Diameter [In mm]</td>
<td>166</td>
<td>166</td>
<td>220</td>
<td>220</td>
</tr>
<tr>
<td>3.2</td>
<td>Base Diameter[In mm]</td>
<td>415</td>
<td>415</td>
<td>485</td>
<td>485</td>
</tr>
<tr>
<td>3.3</td>
<td>Number of Sections[ Nos]</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3.4</td>
<td>Top Sections length[mm] x thickness[mm]</td>
<td>8375X3</td>
<td>8375X4</td>
<td>8375X4</td>
<td>8375X4</td>
</tr>
<tr>
<td>3.5</td>
<td>Middle Section Length[mm] x thickness[mm]</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>3.6</td>
<td>Bottom Section Length[mm] x thickness[mm]</td>
<td>8375X4</td>
<td>8375X4</td>
<td>8375X4</td>
<td>8375X5</td>
</tr>
</tbody>
</table>
### Construction of AIIMS, Guwahati (Assam)

#### Vol-V: Tech Specs

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Qty 1</th>
<th>Qty 2</th>
<th>Qty 3</th>
<th>Qty 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.7</td>
<td>Overlapping [between Sections]</td>
<td>375</td>
<td>375</td>
<td>375</td>
<td>375</td>
</tr>
<tr>
<td>3.8</td>
<td>Base Flange Diameter [mm]</td>
<td>630</td>
<td>630</td>
<td>730</td>
<td>730</td>
</tr>
<tr>
<td>3.9</td>
<td>Base Flange Thickness [mm]</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>3.10</td>
<td>P.C.D [mm] x Hole Dimensions [mm]</td>
<td>530</td>
<td>530</td>
<td>630</td>
<td>630</td>
</tr>
<tr>
<td>3.11</td>
<td>No of Bolts [Qty]</td>
<td>8</td>
<td>8</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>3.12</td>
<td>Foundation bolts Details</td>
<td>1200x24 mm</td>
<td>1200x24 mm</td>
<td>1200x24 mm</td>
<td>1200x24 mm</td>
</tr>
<tr>
<td>3.13</td>
<td>Metal Treatment protection for Mast</td>
<td>Galvanised</td>
<td>Galvanised</td>
<td>Galvanised</td>
<td>Galvanised</td>
</tr>
<tr>
<td>3.14</td>
<td>Thickness of Galvanisation [min.]</td>
<td>min 65 micron for 2 mm up to 4 mm and 86 Microns for 5 mm and above.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.15</td>
<td>Size of opening and door at base</td>
<td>1000mmx300mm</td>
<td>1000mmx300mm</td>
<td>1000mmx300mm</td>
<td>1000mmx300mm</td>
</tr>
<tr>
<td>3.16</td>
<td>Type of locking arrangement</td>
<td>Anti-Vandalism</td>
<td>Anti-Vandalism</td>
<td>Anti-Vandalism</td>
<td>Anti-Vandalism</td>
</tr>
<tr>
<td>3.17</td>
<td>Size of anchor plate &amp; thickness</td>
<td>730mmx6mm</td>
<td>730mmx6mm</td>
<td>730mmx6mm</td>
<td>730mmx6mm</td>
</tr>
<tr>
<td>3.18</td>
<td>Details of template</td>
<td>730mmx6mm</td>
<td>730mmx6mm</td>
<td>730mmx6mm</td>
<td>730mmx6mm</td>
</tr>
<tr>
<td>4</td>
<td>HEAD FRAME</td>
<td>3-POINT</td>
<td>3-POINT</td>
<td>3-POINT</td>
<td>3-POINT</td>
</tr>
<tr>
<td>4.1</td>
<td>Construction</td>
<td>MS. Fabricated</td>
<td>MS. Fabricated</td>
<td>MS. Fabricated</td>
<td>MS. Fabricated</td>
</tr>
<tr>
<td>4.2</td>
<td>Metal Treatment protection for HEAD FRAME</td>
<td>Galvanised</td>
<td>Galvanised</td>
<td>Galvanised</td>
<td>Galvanised</td>
</tr>
<tr>
<td>4.3</td>
<td>Pulley Arrangements (For Steel Wire Rope)</td>
<td>3SETS OF PULLEYS</td>
<td>3SETS OF PULLEYS</td>
<td>3SETS OF PULLEYS</td>
<td>3SETS OF PULLEYS</td>
</tr>
<tr>
<td>4.4</td>
<td>Pulley Arrangements (For Electric Cable)</td>
<td>1 set OF PULLEY</td>
<td>1 set OF PULLEY</td>
<td>1 set OF PULLEY</td>
<td>1 set OF PULLEY</td>
</tr>
<tr>
<td>5</td>
<td>LANTERN CARRIAGE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1</td>
<td>Material of Construction</td>
<td>IS2062</td>
<td>IS2062</td>
<td>IS2062</td>
<td>IS2062</td>
</tr>
<tr>
<td>5.2</td>
<td>Diameter of Carriage Ring [mm]</td>
<td>1200</td>
<td>1200</td>
<td>1200</td>
<td>1200</td>
</tr>
<tr>
<td>5.3</td>
<td>Construction</td>
<td>M.S fabricated</td>
<td>M.S fabricated</td>
<td>M.S fabricated</td>
<td>M.S fabricated</td>
</tr>
<tr>
<td>5.4</td>
<td>Number of joints</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5.5</td>
<td>Buffer arrangements between Carriage &amp; MAST</td>
<td>Will be provided</td>
<td>Will be provided</td>
<td>Will be provided</td>
<td>Will be provided</td>
</tr>
<tr>
<td>6</td>
<td>Compensating Disc between L-Ring and DD Ring</td>
<td>PROVIDED</td>
<td>PROVIDED</td>
<td>PROVIDED</td>
<td>PROVIDED</td>
</tr>
<tr>
<td>7</td>
<td>Safety Locking on both sides at Base of Mast</td>
<td>PROVIDED</td>
<td>PROVIDED</td>
<td>PROVIDED</td>
<td>PROVIDED</td>
</tr>
<tr>
<td>8</td>
<td>Winch</td>
<td>D/Drum, 750 Kg cap</td>
<td>D/Drum, 750 Kg cap</td>
<td>D/Drum, 750 Kg cap</td>
<td>D/Drum, 750 Kg cap</td>
</tr>
<tr>
<td>9</td>
<td>Stainless Steel wires diameter</td>
<td>6 mm</td>
<td>6 mm</td>
<td>6 mm</td>
<td>6 mm</td>
</tr>
<tr>
<td>9.1</td>
<td>Number of Ropes</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Specification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>------------------------------</td>
<td>---------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.2</td>
<td>C/disc to D/d.Winch</td>
<td>two[6mm size]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.3</td>
<td>C/disc to Lantern Ring</td>
<td>Three[6mm size]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.4</td>
<td>Thimbles &amp; Terminals</td>
<td>Provided.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.5</td>
<td>Factor Of Safety</td>
<td>&gt;5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>POWER TOOL</td>
<td>Gear Ration 53:1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.1</td>
<td>Model</td>
<td>Integral</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.2</td>
<td>Input Supply</td>
<td>415v,50c/s;3-ph</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.3</td>
<td>WATTAGE</td>
<td>1.5KW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.4</td>
<td>Num. Of Speeds</td>
<td>Single</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.5</td>
<td>Reversible/Non-reversible</td>
<td>Reversible</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.6</td>
<td>Operating Speed</td>
<td>1400 Rpm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Lightning Arrestor [1.2m Length]</td>
<td>will be provided</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:**

a. Dimensions are subjected to tolerance allowed as per IS.

b. Diameter of wire rope may increase to 8 mm wherever qty. of light fittings are more on lantern carriage.

c. Motor can be supplied in single and three phase as per requirement.

### 20 METER HEIGHT

<table>
<thead>
<tr>
<th>S.No</th>
<th>Description[Lighting Mast]</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>High mast Height[mtrs] incl.Luminaires Carriage</td>
<td>20</td>
</tr>
<tr>
<td>1.1</td>
<td>Material Construction</td>
<td>BSEN100025 or Eqiv</td>
</tr>
<tr>
<td>1.2</td>
<td>Welding</td>
<td>As per IS</td>
</tr>
<tr>
<td>1.3</td>
<td>No.Of Sides</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>WIND LOAD DATA taken for this project</td>
<td>as per IS 875</td>
</tr>
<tr>
<td>3</td>
<td>Mast Section Details</td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Top Diameter [In mm]</td>
<td>166</td>
</tr>
<tr>
<td>3.2</td>
<td>Base Diameter[In mm]</td>
<td>419</td>
</tr>
<tr>
<td>3.3</td>
<td>Number of Sections[ Nos]</td>
<td>2</td>
</tr>
<tr>
<td>3.4</td>
<td>Top Sections Length[mm]xthickness[mm]</td>
<td>10375X3</td>
</tr>
<tr>
<td>3.5</td>
<td>Middle SectionLength[mm]xthickness[ mm]</td>
<td>NA</td>
</tr>
<tr>
<td>Section</td>
<td>Description</td>
<td>Quantity/Dimensions</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>3.6</td>
<td>Bottom Section Length[mm]xthickness[mm]</td>
<td>10375X4</td>
</tr>
<tr>
<td>3.7</td>
<td>Overlapping [between Sections]</td>
<td>375</td>
</tr>
<tr>
<td>3.8</td>
<td>Base Flange Diameter[mm]</td>
<td>630</td>
</tr>
<tr>
<td>3.9</td>
<td>Base Flange Thickness[mm]</td>
<td>32</td>
</tr>
<tr>
<td>3.10</td>
<td>P.C.D [mm] x Hole Dimensions [mm]</td>
<td>530</td>
</tr>
<tr>
<td>3.11</td>
<td>No. Of Bolts[Qty]</td>
<td>12</td>
</tr>
<tr>
<td>3.12</td>
<td>Foundation bolts Details</td>
<td>1200x24 mm</td>
</tr>
<tr>
<td>3.13</td>
<td>Metal Treatment Protection for Mast</td>
<td>Galvanised</td>
</tr>
<tr>
<td>3.14</td>
<td>Thickness of Galvanisation (min.)</td>
<td>min 65 micron for sheet thickness of 2mm up to 4 mm and 86 Microns for 5 mm and above.</td>
</tr>
<tr>
<td>3.15</td>
<td>Size of opening and door at base</td>
<td>1000mmx300 mm</td>
</tr>
<tr>
<td>3.16</td>
<td>Type of locking arrangement</td>
<td>Anti-Vandalism</td>
</tr>
<tr>
<td>3.17</td>
<td>Size of Anchor Plate &amp; Thickness</td>
<td>630mmx6mm</td>
</tr>
<tr>
<td>3.18</td>
<td>Details of Template</td>
<td>630mmx6mm</td>
</tr>
<tr>
<td>4.1</td>
<td>Construction</td>
<td>MS, Fabricated</td>
</tr>
<tr>
<td>4.2</td>
<td>Metal Treatment protection for HEAD FRAME</td>
<td>Galvanised</td>
</tr>
<tr>
<td>4.3</td>
<td>Pulley Arrangements (For Steel Wire Rope)</td>
<td>3SETS OF PULLEYS</td>
</tr>
<tr>
<td>4.4</td>
<td>Pulley Arrangements (For Electric Cable)</td>
<td>1 set OF PULLEY</td>
</tr>
<tr>
<td>5.1</td>
<td>Material of Construction</td>
<td>IS2062</td>
</tr>
<tr>
<td>5.2</td>
<td>Diameter of Carriage Ring(mm)-1NO</td>
<td>1200</td>
</tr>
<tr>
<td>5.3</td>
<td>Construction</td>
<td>M.S fabricated</td>
</tr>
<tr>
<td>5.4</td>
<td>Number of Joints</td>
<td>3</td>
</tr>
<tr>
<td>5.5</td>
<td>Buffer arrangements between Carriage &amp; MAST</td>
<td>Will be provided</td>
</tr>
<tr>
<td>6.1</td>
<td>Compensating Disc between L-Ring and DD Ring</td>
<td>PROVIDED</td>
</tr>
<tr>
<td></td>
<td>Description[Lighting Mast]</td>
<td>Specification</td>
</tr>
<tr>
<td>---</td>
<td>------------------------------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>25 METER HEIGHT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.No</td>
<td>Type</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>High mast Height[mtrs] incl.Luminaires Carriage</td>
<td>25</td>
</tr>
<tr>
<td>1.1</td>
<td>Material Construction</td>
<td>BSEN100025 or Eqiv</td>
</tr>
<tr>
<td>1.2</td>
<td>Welding</td>
<td>As per IS</td>
</tr>
<tr>
<td>1.3</td>
<td>No.Of Sides</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Details</td>
<td>Wind Load Data</td>
</tr>
<tr>
<td>---</td>
<td>---------</td>
<td>----------------</td>
</tr>
<tr>
<td>2</td>
<td>WIND LOAD DATA taken for this project</td>
<td>as per IS 875</td>
</tr>
<tr>
<td>3</td>
<td>Mast Section Details</td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Top Diameter [In mm]</td>
<td>206</td>
</tr>
<tr>
<td>3.2</td>
<td>Base Diameter [In mm]</td>
<td>500</td>
</tr>
<tr>
<td>3.3</td>
<td>Number of Sections [Nos]</td>
<td>3</td>
</tr>
<tr>
<td>3.4</td>
<td>Top Sections length [mm] x thickness [mm]</td>
<td>9000X4</td>
</tr>
<tr>
<td>3.5</td>
<td>Middle Section</td>
<td>9000X4</td>
</tr>
<tr>
<td>3.6</td>
<td>Bottom Section Length [mm] x thickness [mm]</td>
<td>9000X5</td>
</tr>
<tr>
<td>3.7</td>
<td>Over lapping [between Sections]</td>
<td>1000/900</td>
</tr>
<tr>
<td>3.8</td>
<td>Base Flange Diameter [mm]</td>
<td>730</td>
</tr>
<tr>
<td>3.9</td>
<td>Base Flange Thickness [mm]</td>
<td>32</td>
</tr>
<tr>
<td>3.10</td>
<td>P.C.D [mm] x Hole Dimensions [mm]</td>
<td>630</td>
</tr>
<tr>
<td>3.11</td>
<td>No. Of Bolts [Qty]</td>
<td>20</td>
</tr>
<tr>
<td>3.12</td>
<td>Foundation bolts Details</td>
<td>1200x24 mm</td>
</tr>
<tr>
<td>3.13</td>
<td>Metal Treatment protection for Mast</td>
<td></td>
</tr>
<tr>
<td>3.14</td>
<td>Thickness of Galvanisation (min.)</td>
<td></td>
</tr>
<tr>
<td>3.15</td>
<td>Size of opening and door at base</td>
<td>1000mmx300mm</td>
</tr>
<tr>
<td>3.16</td>
<td>Type of locking arrangement</td>
<td>Anti-Vandalism</td>
</tr>
<tr>
<td>3.17</td>
<td>Size of anchor plate &amp; thickness</td>
<td>730mmx6mm</td>
</tr>
<tr>
<td>3.18</td>
<td>Details of template</td>
<td>730mmx6mm</td>
</tr>
<tr>
<td>4</td>
<td>HEAD FRAME</td>
<td>3-POINT</td>
</tr>
<tr>
<td>4.1</td>
<td>Construction</td>
<td>MS Fabricated</td>
</tr>
<tr>
<td>4.2</td>
<td>Metal Treatment protection for HEAD FRAME</td>
<td>Galvanised</td>
</tr>
<tr>
<td>4.3</td>
<td>Pulley Arrangements (For Steel Wire Rope)</td>
<td>3SETS OF PULLEYS</td>
</tr>
<tr>
<td>4.4</td>
<td>Pulley Arrangements (For Electric Cable)</td>
<td>1 set OF PULLEY</td>
</tr>
<tr>
<td>5</td>
<td>LANTERN CARRIAGE</td>
<td></td>
</tr>
<tr>
<td>5.1</td>
<td>Material of Construction</td>
<td>IS2062</td>
</tr>
<tr>
<td>5.2</td>
<td>Diameter of Carriage Ring (mm) - 1 NO</td>
<td>1200</td>
</tr>
<tr>
<td>5.3</td>
<td>Construction</td>
<td>M.S fabricated</td>
</tr>
<tr>
<td>5.4</td>
<td>Number of Joints</td>
<td>3</td>
</tr>
<tr>
<td>5.5</td>
<td>Buffer arrangements between Carriage &amp; MAST</td>
<td>Will be provided</td>
</tr>
</tbody>
</table>
### 6. Compensating Disc between L-Ring and DD Ring
- Provided
- Provided
- Provided

### 7. Safety Locking on both sides at Base of Mast
- Provided
- Provided
- Provided

### 8. Winch
- D/Drum, 750 Kg cap
- D/Drum, 750 Kg cap
- D/Drum, 750 Kg cap

### 9. Stainless Steel wires diameter
- 6 mm
- 6 mm
- 6 mm

### 9.1 Number of Ropes
- 3
- 3
- 3

### 9.2 C/disc to D/d Winch
- Two (6mm size)
- Two (6mm size)
- Two (6mm size)

### 9.3 C/disc to Lantern Ring
- Three (6mm size)
- Three (6mm size)
- Three (6mm size)

### 9.4 Thimbles & Terminals
- Provided
- Provided
- Provided

### 9.5 Factor Of Safety
- >5
- >5
- >5

### 10. POWER TOOL
- Gear Ration 53:1
- Gear Ration 53:1
- Gear Ration 53:1

#### 10.1 Model
- Integral
- Integral
- Integral

#### 10.2 Input Supply
- 415v, 50c/s; 3-ph
- 415v, 50c/s; 3-ph
- 415v, 50c/s; 3-ph

#### 10.3 Wattage
- 1.5KW
- 1.5KW
- 1.5KW

#### 10.4 Num. Of Speeds
- Single
- Single
- Single

#### 10.5 Reversible/Non-reversible
- Reversible
- Reversible
- Reversible

#### 10.6 Operating Speed
- 1400 Rpm
- 1400 Rpm
- 1400 Rpm

### 11. Lightning Arrestor [1.2m Length]
- Will be provided
- Will be provided
- Will be provided

### 12. Aviation Obstruction light
- Provision for mounting will be provided
- Provision for mounting will be provided
- Provision for mounting will be provided

**Note:**
- a. Dimensions are subjected to tolerance allowed as per IS.
- b. Diameter of wire rope may increase to 8mm wherever qty. of light fittings are more on lantern carriage.
- c. Motor can be supplied in single and three phase as per requirement.

### 30 METER HEIGHT

<table>
<thead>
<tr>
<th>S.No</th>
<th>Description</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Type</td>
</tr>
<tr>
<td>1</td>
<td>HIGH MAST HEIGHT[MTRS] INC: LUMINAIRES CARRIAGE</td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>MATERIAL CONSTRUCTION</td>
<td>BSEN100025 OR EQIV</td>
</tr>
<tr>
<td>1.2</td>
<td>WELDING</td>
<td>AS PER IS</td>
</tr>
<tr>
<td>1.3</td>
<td>NO. OF SIDES</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>WIND LOAD DATA TAKEN FOR THIS PROJECT</td>
<td>AS PER IS 875</td>
</tr>
<tr>
<td>3</td>
<td>MAST SECTION DETAILS</td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>TOP DIAMETER [IN MM]</td>
<td>166</td>
</tr>
<tr>
<td>3.2</td>
<td>BASE DIAMETER [IN MM]</td>
<td>578</td>
</tr>
<tr>
<td>3.3</td>
<td>NUMBER OF SECTIONS [NOS]</td>
<td>3</td>
</tr>
<tr>
<td>3.4</td>
<td>TOP SECTIONS LENGTH [MM] XTHICKNESS [MM]</td>
<td>10600X4</td>
</tr>
<tr>
<td>3.5</td>
<td>MIDDLE SECTION LENGTH [MM] XTHICKNESS [MM]</td>
<td>10650X4</td>
</tr>
</tbody>
</table>
### 3.6 BOTTOM SECTION LENGTH [MM] X THICKNESS [MM]
- 10650X4
- 10650X5
- 10650X6
- 10650X6
- 10650X6

### 3.7 OVER LAPPIING [BETWEEN SECTIONS]
- 1000/900
- 1000/900
- 1000/900
- 1000/900
- 1000/900

### 3.8 BASE FLANGE DIAMETER [MM]
- 770
- 830
- 890
- 890
- 990

### 3.9 BASE FLANGE THICKNESS [MM]
- 32
- 32
- 32
- 32
- 32

### 3.10 P.C.D [MM] X HOLE DIMENSIONS [MM]
- 690
- 730
- 790
- 790
- 890

### 3.11 NO. OF BOLTS [QTY]
- 16
- 20
- 20
- 20
- 20

### 3.12 FOUNDATION BOLTS DETAILS
- 1200X24 MM
- 1200X24 MM
- 1200X32 MM
- 1200X32 MM
- 1200X32 MM

### 3.13 METAL TREATMENT
- PROTECTION FOR MAST
  - GALVANISED
  - GALVANISED
  - GALVANISED
  - GALVANISED
  - GALVANISED

### 3.14 THICKNESS OF GALVANISATION [MIN.]
- 65 MICRON FOR SHEET THICKNESS
- 65 MICRON FOR 2MM UP TO 4MM AND ABOVE.
- 86 MICRONS FOR 5MM AND ABOVE.

### 3.15 SIZE OF OPENING AND DOOR AT BASE
- 1000MMX300MM
- 1000MMX300MM
- 1000MMX300MM
- 1000MMX300MM
- 1000MMX300MM

### 3.16 TYPE OF LOCKING ARRANGEMENT
- ANTI-VANDALISM
- ANTI-VANDALISM
- ANTI-VANDALISM
- ANTI-VANDALISM
- ANTI-VANDALISM

### 3.17 SIZE OF ANCHOR PLATE & THICKNESS
- 730MMX6MM
- 730MMX6MM
- 730MMX6MM
- 730MMX6MM
- 730MMX6MM

### 3.18 DETAILS OF TEMPLATE
- 730MMX6MM
- 730MMX6MM
- 730MMX6MM
- 730MMX6MM
- 730MMX6MM

### 4 HEAD FRAME
- 3-POINT
- 3-POINT
- 3-POINT
- 3-POINT
- 3-POINT

### 4.1 CONSTRUCTION
- MS.FABRICATED
- MS.FABRICATED
- MS.FABRICATED
- MS.FABRICATED
- MS.FABRICATED

### 4.2 METAL TREATMENT PROTECTION FOR HEAD FRAME
- GALVANISED
- GALVANISED
- GALVANISED
- GALVANISED
- GALVANISED

### 4.3 PULLEY ARRANGEMENTS (FOR STEEL WIRE ROPE)
- 3SETS OF PULLEYS
- 3SETS OF PULLEYS
- 3SETS OF PULLEYS
- 3SETS OF PULLEYS
- 3SETS OF PULLEYS

### 4.4 PULLEY ARRANGEMENTS (FOR ELECTRIC CABLE)
- 1 SET OF PULLEY
- 1 SET OF PULLEY
- 1 SET OF PULLEY
- 1 SET OF PULLEY
- 1 SET OF PULLEY

### 5 LANTERN CARRIAGE
### 5.1 MATERIAL OF CONSTRUCTION
- IS2062
- IS2062
- IS2062
- IS2062
- IS2062

### 5.2 DIAMETER OF CARRIAGE RING [MM]-1 NO
- 1200
- 1200
- 1200
- 1200
- 1200

### 5.3 CONSTRUCTION
- M.S FABRICATED
- M.S FABRICATED
- M.S FABRICATED
- M.S FABRICATED
- M.S FABRICATED

### 5.4 NUMBER OF JOINTS
- 3
- 3
- 3
- 3
- 3

### 5.5 BUFFER ARRANGEMENTS BETWEEN CARRIAGE & MAST
- WILL BE PROVIDED
- WILL BE PROVIDED
- WILL BE PROVIDED
- WILL BE PROVIDED
- WILL BE PROVIDED

### 6 COMPENSATING DISC BETWEEN L-RING AND DD RING
- PROVIDED
- PROVIDED
- PROVIDED
- PROVIDED
- PROVIDED

### 7 SAFETY LOCKING ON BOTH SIDES AT BASE OF MAST
- PROVIDED
- PROVIDED
- PROVIDED
- PROVIDED
- PROVIDED

### 8 WINCH
- D/DRUM, 750 KG CAP
- D/DRUM, 750 KG CAP
- D/DRUM, 750 KG CAP
- D/DRUM, 750 KG CAP
- D/DRUM, 750 KG CAP

### 9 STAINLESS STEEL WIRES DIAMETER
- 6 MM
- 6 MM
- 8 MM
- 8 MM
- 8 MM

### 9.1 NUMBER OF ROPES
- 3
- 3
- 3
- 3
- 3

### 9.2 C/DISC TO D/D WINCH
- TWO (6MM SIZE)
- TWO (6MM SIZE)
- TWO (6MM SIZE)
- TWO (6MM SIZE)
- TWO (6MM SIZE)

### 9.3 C/DISC TO LANTERN RING
- THREE (6MM SIZE)
- THREE (6MM SIZE)
- THREE (6MM SIZE)
- THREE (6MM SIZE)
- THREE (6MM SIZE)

### 9.4 THIMBLES & TERMINALS
- PROVIDED
- PROVIDED
- PROVIDED
- PROVIDED
- PROVIDED
9.5 FACTOR OF SAFETY >5 >5 >5 >5 >5

10 POWER TOOL GEAR RATION 53:1 GEAR RATION 53:1 GEAR RATION 53:1 GEAR RATION 53:1 GEAR RATION 53:1

10.1 MODEL INTEGRAL INTEGRAL INTEGRAL INTEGRAL INTEGRAL

10.2 INPUT SUPPLY 415V,50C/3;3-PH 415V,50C/3;3-PH 415V,50C/3;3-PH 415V,50C/3;3-PH 415V,50C/3;3-PH

10.3 WATTAGE 1.5KW 1.5KW 2.2KW 2.2 KW 2.2 KW

10.4 NUM. OF SPEEDS SINGLE SINGLE SINGLE SINGLE SINGLE

10.5 REVERSIBLE/NON-REVERSIBLE REVERSIBLE REVERSIBLE REVERSIBLE REVERSIBLE REVERSIBLE

10.6 OPERATING SPEED 1400 RPM 1400 RPM 1400 RPM 1400 RPM 1400 RPM

11 LIGHTNING ARRESTOR [1.2M LENGTH] WILL BE PROVIDED WILL BE PROVIDED WILL BE PROVIDED WILL BE PROVIDED WILL BE PROVIDED

12 AVIATION OBSTRUCTION LIGHT PROVISION FOR MOUNTING WILL BE PROVIDED

**Note:**

a. Dimensions are subjected to tolerance allowed as per IS.

b. Diameter of wire rope may increase to 8mm wherever qty. of light fittings are more on lantern carriage.

c. Motor can be supplied in single and three phase as per requirement.

23.3. 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 DESCRIPTION</th>
<th>POLE DETAILS</th>
<th>FOUNADATION BOLT DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>POLE DETAILS</td>
<td>FOUNADATION BOLT DETAILS</td>
</tr>
<tr>
<td></td>
<td>HEIGHT</td>
<td>TOP</td>
</tr>
<tr>
<td>3 MTR GI OCTAGONAL POLE</td>
<td>3000</td>
<td>70</td>
</tr>
<tr>
<td>4 MTR GI OCTAGONAL POLE</td>
<td>4000</td>
<td>70</td>
</tr>
<tr>
<td>5 MTR GI OCTAGONAL POLE</td>
<td>5000</td>
<td>70</td>
</tr>
<tr>
<td>6 MTR GI OCTAGONAL POLE</td>
<td>6000</td>
<td>70</td>
</tr>
<tr>
<td>7 MTR GI OCTAGONAL POLE</td>
<td>7000</td>
<td>70</td>
</tr>
<tr>
<td>8 MTR GI OCTAGONAL POLE</td>
<td>8000</td>
<td>70</td>
</tr>
<tr>
<td>9 MTR GI OCTAGONAL POLE</td>
<td>9000</td>
<td>70</td>
</tr>
<tr>
<td>10 MTR GI OCTAGONAL POLE</td>
<td>10000</td>
<td>70</td>
</tr>
<tr>
<td>11 MTR GI OCTAGONAL POLE</td>
<td>11000</td>
<td>90</td>
</tr>
<tr>
<td>12 MTR GI OCTAGONAL POLE</td>
<td>12000</td>
<td>90</td>
</tr>
</tbody>
</table>

**NOTE:** ALL DIMENSIONS ARE IN MM.
24. Solar Street Lighting System

24.1. Scope of Work:

Solar Street Lighting System shall comprise of Solar Panel Module, LED Luminaires, Solar Charge Controller /LED driver in a single PCB, SMF Battery with 36 hours back up, Hybrid Charger etc. Mounting System shall include, panel frame, panel holder, Battery Box, Battery Box Stand, Luminaire arm, GI Octagonal Pole etc.

Maximum Power Point Tracking (MPPT) System shall be provided with charge controllers for extracting maximum available power from PV module under certain conditions. MPPT (18 W – 45W) Solar Charge Controller with maximum efficiency shall be provided as per Lux level requirements to maximise the generation of solar power.

24.2. Features of Solar Street Light Poles:

<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>
</tbody>
</table>
### Charge controller efficiency
<table>
<thead>
<tr>
<th></th>
<th>&gt;96%</th>
<th>&gt;96%</th>
<th>&gt;96%</th>
<th>&gt;96%</th>
<th>&gt;96%</th>
<th>&gt;96%</th>
</tr>
</thead>
</table>
### LED Driver efficiency
|                | >96% | >96% | >96% | >96% | >96% | >96% |
| No of Leds     | 8    | 8    | 8    | 12   | 12   | 12   |
| No Load current from battery | <10mA | <10mA | <10mA | <10mA | <10mA | <10mA |
### Housing
|                | LM6 PDC Housing | LM6 PDC Housing | LM6 PDC Housing | LM6 PDC Housing | LM6 PDC Housing | LM6 PDC Housing |
| Front Cover    | Toughened Glass | Toughened Glass | Toughened Glass | Toughened Glass | Toughened Glass | Toughened Glass |
| Ingress Protection | IP66, Class I | IP66, Class I | IP66, Class I | IP66, Class I | IP66, Class I | IP66, Class I |
| Life           | 50,000Hrs@ L70 | 50,000Hrs@ L70 | 50,000Hrs@ L70 | 50,000Hrs@ L70 | 50,000Hrs@ L70 | 50,000Hrs@ L70 |
| CCT            | 5700K (+/- 5SDCM) | 5700K (+/- 5SDCM) | 5700K (+/- 5SDCM) | 5700K (+/- 5SDCM) | 5700K (+/- 5SDCM) | 5700K (+/- 5SDCM) |
| CRI            | >70   | >70   | >70   | >70   | >70   | >70   |
### Solar Panel
- Battery: 75 WP, 75 AH, 100AH
- Battery Box: Sheet Metal, Sheet Metal, Sheet Metal
- Autonomy (battery backup): 3 days, 3 days, 3 days
### Pole Height (Above ground)
- 5 MTS OCTAGONAL 4 MM THICK
### Other accessories
- Battery stand, Panel holder, Arm 0.5 mts 5 degree tilt
- Battery stand, Panel holder, Arm 0.5 mts 5 degree tilt
### Façade & Flood Lighting:
Façade illumination shall be achieved by providing LED based flood lights, outdoor type light fittings (IP-66) with impactful and bright lighting effects in wide area. These flood lights shall be housed in High Pressure die-cast aluminum housing with sealed glass/polycarbonate cover. The light shall be mounted with various angular adjustments with beam angles generally ranging from 15 degree to 120 degree. Luminous efficacy must be more than 100 Lumen/watt and Color Rendering Index (CRI) more than 70.

These light should have integrated constant current Electronic driver with nominal voltage range from 120 Volt to 280 Volt, Operating Temperature -20 degree C to 50 degreeC, Total Harmonic distortion less than 10%, Power Factor > 0.95, Electrical safety class, Built in surge protection of upto 10 kV.
<table>
<thead>
<tr>
<th>Feature</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Board Over Temperature Fault:</td>
<td>To be Provided</td>
</tr>
<tr>
<td>Battery Not Connect Fault</td>
<td>To be Provided</td>
</tr>
<tr>
<td>Battery Over Voltage Fault</td>
<td>To be Provided</td>
</tr>
<tr>
<td>Panel Over Voltage Fault</td>
<td>To be Provided</td>
</tr>
<tr>
<td>Load Short Circuit Protection</td>
<td>To be Provided</td>
</tr>
<tr>
<td>Load OVP</td>
<td>To be Provided</td>
</tr>
<tr>
<td>Battery Under Voltage Fault</td>
<td>To be Provided</td>
</tr>
<tr>
<td>Environmental</td>
<td></td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>-0˚C to +50˚C</td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>-20˚C to +85˚C</td>
</tr>
<tr>
<td>Humidity</td>
<td>95%RH</td>
</tr>
<tr>
<td>Battery Temperature Compensation</td>
<td>To be Provided</td>
</tr>
<tr>
<td>Ingress Protection</td>
<td>Ingress Protection, IP66</td>
</tr>
<tr>
<td>Embossing</td>
<td>Luminaire must be embossed with original equipment Manufacturer name To be Provided</td>
</tr>
<tr>
<td>Dimming Feature</td>
<td>50% auto Dim after 5hrs.</td>
</tr>
</tbody>
</table>

24.4. 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.

24.5. 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.

24.6. 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 tests
25. SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEM (SCADA)

25.1. Scope of Work:

Scope of work includes supplying, installation, testing and commissioning of SCADA System for monitoring and controlling of various electrical parameters of equipment installed in all substations at AIIMS campus complete as required. Complete Hardware, Software, cabling & other ancillary items as required for smooth functioning of the SCADA System shall be supplied, installed, tested & commissioned. The system shall be capable to work on minimum 100 mbps speed. The SCADA System shall comprise of, but not limited to, following scope of work:

i. Installing and commissioning of PLC programming software with licensed version of languages as per IEC 61131.

ii. Supplying, installation, testing and commissioning a set of the media converters to inter-connect the different sub-system including field instrumentation, RTUs/Processors, CPUs & OFC cable Gateway, transferring and monitoring the data and signals to the respective components.

iii. Supplying, installation, testing and commissioning of redundant PLC/ CPU and IO modules at remote locations (all 3 Substations) for controlling and monitoring the status of switchgears with 100% redundancy as per system architecture.

iv. SCADA System shall monitor & control various electrical parameters combined for all substations as well as for individual substations. SCADA system shall control the operations of HT breakers, LT breakers & MCCBs as per requirement of user both in Auto & Manual mode. SCADA system shall also communicate the Numerical relays both at HT & LT side of the system to read the parameters & faults, whenever arises in the system. Various electrical parameters to be monitored & controlled, but not limited to, are: kVA, kW, kVAR, kVArh, kWh, kVARh, phase-phase voltages, phase-neutral voltages, phase-neutral currents, Hz, harmonic distortion in each phase, Total harmonic Distortion, Power Factor, sinusoidal waveform in each phase, ON/OFF/TRIP status of Incoming/Outgoing VCBs, ACBs, MCCBs etc.

v. Supplying, installation, testing and commissioning of communication gateway, RS485 MODBUS (19.2 kbps) to Ethernet TCP/IP (10 MBPS) with 24 V DC & 230 V AC 50 Hz, shall be provided to connect all the MODBUS Devices viz. MFM, ACBs, Numerical Relays, DG controlling/ synchronizing, APFCR Panels etc. The supplier shall design the gateways so that each gateway shall take only 10 such devices to maintain the data speed.

vi. Supply of high speed low loss data communication 4 pair armoured (CAT-6 cable) cable suitable for Ethernet TCP/IP application with 0.9 mm. tinned copper conductor, insulated as per the relevant IS Standard to form the backbone data communication network. The cable should have permissible noise attenuation required for the application.

vii. Supply of Fiber Optic Cable 6 core, armoured for outdoor application as per the relevant IS standard to form the backbone data communication network.

viii. All cables for interconnecting various substations with SCADA System shall be laid in Hume Pipes.

ix. Schematic diagram & system architecture for SCADA System shall be prepared & got approved from Engineer-In-Charge before commencement of works at site. EPC Contractor may provide Hardware, Software & cabling etc. for SCADA Scheme with higher configuration, as required.

25.2. SCADA Control Room

i. SCADA Control Room complete in all respects shall be established in Electrical Substation-1. SCADA Control Room shall require supply, installation, testing and commissioning of dedicated branded computer for SCADA-Pentium IV PC with 3.2 GHz, 2 GB RAM, 160 GB HDD, 2 serial and 1 parallel ports, 1 LAN port, 4 spare USB port DVD combo, latest antivirus software (original compatible with OS & Color Monitor 21‖ LCD, UPS (1 KVA) suitable for CPU & Monitor, A4 Size color printer, pen drive etc.

ii. Supply installation testing and commissioning of server for SCADA application with redundant Mode SCADA licensed development & run time software, customized to HITES requirements for
The SCADA system shall be integrated & hooked up to Building Management System (BMS) for monitoring purpose. Necessary hardware and software etc. required for hooking up of SCADA with BMS is included in the scope of works.

25.3. SCADA SOFTWARE:-

A. GENERAL

1. Description: The SCADA software package shall support latest server hardware. The SCADA software shall be part of a complete SCADA system. This system shall include personal computer(s) and industry standard networking hardware.

2. Core SCADA functionality: All core SCADA functionality offered, such as communications drivers, graphics capabilities, reporting, historical storage, trend and alarm displays and the development environment are offered as a single integrated software package or suite of packages. The software must be designed with the ability to make changes in the graphics while the system is running. Shutting down the SCADA server for graphic changes is not acceptable.

3. Operating Systems: As a minimum, the SCADA software shall run server, development and runtime implementations on the following Microsoft 64-bit operating systems.
   a. Windows Server 2012 R2
   b. Windows 10 Professional
   c. Windows 8.1 Professional
   d. Windows 7 SP1 Professional

4. Multiple operating systems: The SCADA software shall be capable of being implemented on any combination of the specified operating systems. For example the SCADA server may be implemented on a Windows server 2012 R2 platform, the clients on a Windows 10 platform and the development performed on a Windows 7 SP1 platform.

5. Windows Services: It shall be possible to run the SCADA software as a service under Windows.

6. SCADA Application: The SCADA software and engineering configuration shall support:
   a. SCADA servers: Single or redundant server based on the system requirement.
   b. SCADA should support client-server architecture and use TCP/IP communication between SCADA server and operator stations.
   c. SCADA operator stations: SCADA should support operator station for monitoring & controlling process information.
   d. User tags: SCADA should support concept of user tags for mapping PLCs/RTUs etc. tags onto the SCADA. It should be possible to use user tags for calculations if needed.
   e. System tags: SCADA should support system/Internal tags for exchanging information from communication drivers, redundant system etc.
   f. SCADA should concept of Object Oriented Programming and support scripting language. Also scripting language should support concept of object oriented programming.
   g. It should be possible for SCADA to realize real world objects in SCADA’s real time database.
h. SCADA should support separate database for process configuration and archiving of information.

B. CONNECTIVITY:

1. Description: The SCADA software shall support reading and writing of data from PLC’s, RTU’s using communication drivers. The driver shall provide the data on request or based on change depending on driver selection.

2. General driver capabilities:
   The SCADA software shall support Primary and Standby Servers to provide automatic redundancy in the event of a Primary Server failure without any user intervention or special scripting required. This switch over from a Primary to a Standby Server shall be accomplished in under 10 second when a communication failure is detected.

3. As a minimum the software shall be provided with the following connectivity options to 3rd party programs or databases:
   a. OPC Client: for collecting information from third party system
   b. OPC Server: for providing data to third party system
   c. MQTT Client: for providing data to Internet of Things (IoT) platform
   d. RESTful Web Services: for operating technology and information technology integration.

4. Custom Driver Generation:
   a. The contractor shall ensure that SCADA software vendor shall have a package available that allows the generation of user-written device drivers.

C. COMMUNICATIONS

1. Description: The SCADA software shall be capable of communicating to PLCs connected to the network, remote PLCs, RTUs, BCUs, BPUs, IEDs, DDC, I/O servers, Meters and other devices on the network.

2. General communication capabilities. The SCADA software shall have the following communications capabilities:
   a. Support of redundant communication paths to field controllers, and provision for automatic changeover to the standby path in the event of a communications failure.
   b. Support of communication to redundant field controllers. If a primary processor fails, the software shall automatically detect the failure and switch to communicating to the standby processor. This shall require no user intervention, special scripting or use of redundant tags within the software.
   c. Built in diagnostic alarms shall be provided with the system that will automatically notify the operator of the failure of any communications path.
   d. A package of communication drivers that shall include the following as a minimum:
      - Modbus TCP/IP
      - IEC 60870-5-104
      - DNP 3.0
      - IEC 61850 MMS
      - SNMP
      - Siemens S7 protocol
OPC-DA

3. Communication re-establishment:
   a. Despite the failure, upon re-establishment of communications all buffered data stored at remote field device (RTU)/IED shall be automatically backfilled into the native SCADA data.

D. SECURITY

1. Description: Security features shall be fully integrated to allow only users with appropriate security levels access to individual parts of the system.

2. Security Capabilities: The SCADA software shall have the following:
   a. Encrypted passwords that are checked on the server side.
   b. Passwords hidden in both the configuration and runtime environments to ensure that other personnel cannot access another account.
   c. Monitoring and logging of each control action of each user. This shall include all operator control actions, including system log in and log out. The sequence of actions shall be viewable within the SCADA package and also stored in an external open file format (e.g. txt, csv, sql) for later analysis.
   d. A minimum of 5 privilege levels for each user. The software shall ensure that a user has access to all tasks for his privilege level. If the user does not have the correct privilege for a task a message will indicate insufficient privilege.
   e. Assign each graphic object to a plant area, define the privilege level, define whether operator input is enabled or disabled, and if the object will be visible or not based on the operator's current privilege levels within the plant area.
   f. A mechanism to restrict access to different areas of the plant for each individual user or group of users.

E. GRAPHICAL DISPLAYS

1. Description: Graphical displays are windows that are used to represent part or all of a process in a graphical manner.

2. General Graphical Display Capabilities: The SCADA software shall have the following graphical display features:
   a. Unlimited number of graphical displays:
   b. Supports data change based graphical display mechanism for minimizing burden on CPU
   c. Support full 32 bit graphics, and capable of displaying images from 3rd party packages for use within the SCADA displays, including animating and color flooding the image
   d. Capable of pop-up windows for trends, loops, device status, and device control by clicking on hot spots or objects on the main graphics page.
   e. Inclusion of page name on all graphical displays.
   f. Ability to allow the user to navigate around the graphics system utilizing a variety of navigation methods.
   g. Windows style navigation menus allowing access to any configured page in the system from any other page.
h. Configured with “hot spots”, where as a user can click on the area and drill down into a detailed view (if available) of the plant area.

i. Ability to display communication loss for a particular I/O point wherever that data is displayed in the software.

3. Dynamic Objects: Dynamic objects are symbols that visually change when a property, tag or expression changes. Dynamic objects shall be as described below:
   a. Support the following graphical dynamic objects as a minimum:
      - freehand lines
      - straight lines
      - poly-lines
      - rectangles
      - ellipses
      - text
      - buttons
      - Bitmaps
   b. Dynamic objects shall have a series of properties that can be used independently or concurrently. Each dynamic object shall have the following properties:
      - Horizontal, Vertical and Rotational movement
      - Up, Down, Left or Right Level Fill
      - Gradient Level Fill
      - On-Off, Multi-State, Integer, Threshold or Gradient Color Change
      - Horizontal and Vertical Size
      - Visibility
      - Keyboard Input
      - Touch (Mouse Up, Down, While Down) input
      - Horizontal and Vertical or Rotational Slider
      - Ability to disable the object based on security levels.
      - Popup information in a “tool tip” form by rolling the mouse over the object

F. DISPLAY CLIENT
   1. Description: Display clients shall connect to the individual station servers to allow personnel on the network to view graphics pages, alarms and trends from all the compressor stations simultaneously.
   2. General display client functionality: The display client shall have the following:
      a. Response times less than 2 seconds to access any real time data on the network.

G. ALARMS
   1. Description: Alarms are meant to alert and operator of an abnormal condition. They are logged, and often times require operator intervention.
   2. General Alarm functionality: The alarm functionality shall have the following:
a. No software limit to the number of alarms supported

b. Acknowledgement on one operator station shall be globally acknowledged and as such shown as Acknowledged on all operator stations. This shall be configured as one common database, with no other programming necessary to enable global acknowledgment of alarms from any PC on the network.

3. Alarm Types: The SCADA software shall monitor analog and discrete variables and calculated conditions, and determine if the variable is in an alarm condition. The SCADA software shall perform the following:

a. All analog alarm properties shall be adjustable without the need to shut the system down. For each Analog Tag, an alarm for each of the following conditions shall be assignable:
   i. LOW-LOW,
   ii. LOW,
   iii. HI,
   iv. HI-HI

b. Discrete alarms shall have an assignable alarm for each of the following:
   i. Variable ON
   ii. Variable OFF

c. All alarm processing shall have the facility for time stamping and can track time to a precision of 1 millisecond.

4. Alarm Display: Alarm display shall have the following:

a. Depending on user’s log-in privileges, it shall be possible to display or acknowledge any alarm and/or the most recent alarm on any page.

b. Alarm shall be configurable in multiple levels. The color of the alarm message shall indicate priority. Text shall be configurable by engineers.

c. Provided with a standard alarm user modifiable display page. The alarm page shall allow for scrolling of alarms, and acknowledgment of individual alarms or all alarms on the page

d. Possibility to display the following information for each alarm as it appears on an alarm display page:
   i. Alarm Tag Name
   ii. Alarm Description
   iii. Value of the Variable
   iv. Alarm Status - Acknowledged, Unacknowledged
   v. Alarm Class
   vi. Alarm Priority
   vii. Time & Date
   viii. User name
   ix. Operator Comments

e. Ability to display each alarm state in a different color (including flashing colors).
f. Based on user’s privileges, it shall be possible to disable alarms on individual basis, by page or by alarm category or all alarms. A disabled alarm page shall indicate to every user what alarms have been disabled.

g. Based on user’s privileges, it shall be possible for user comments to be attached to any alarm. These comments shall either be displayed with the alarm or by clicking on the alarm.

h. Possibility to automatically display any graphic display when an alarm occurs or to dynamically change the appearance of any graphical object based on whether an alarm is On, Off, Acknowledged, Communications Error or Disabled.

i. A mechanism for operators to dynamically define filtering of alarms by alarm name, tag name, date /time range, state or type

5. Alarm Redundancy: All alarm calculations and management shall be performed in the Primary Server. The software shall automatically ensure that if the Primary Server fails, all alarm functions shall continue to operate normally in the standby server. The software shall automatically generate a diagnostic alarm to indicate that the Primary or Standby Server has failed. Adding, deleting or modifying alarms shall not require any changes to the software that handles the redundancy. On restoration of a failed Server, the historical alarm history must synchronize between the Primary and Standby servers so that there are no miss matches in historical alarm history.

H. TRENDS

1. Description: Trends are a collection of data points over time. When viewed over time, the trends will indicate general progression of the data.

2. General Trend Functionality: The software shall have the following functionality.

   a. The number of trends collected shall not be limited by the software.

   b. The software shall be capable of displaying historical trend information with minimum 1 millisecond resolution.

   c. Every tag defined in the system configuration shall be trended.

3. Trend Display: The software shall have the following in its native functionality:

   a. Each operator and login shall be able to see their own fully customized trend pages. These pages must be customizable on line by each user in a drop and drag manor. Any setting available to be made in a configuration environment shall be available to the user to modify the trend graphs in run time. These include the color, scaling, pen selection as examples.

   b. Where more than one variable is displayed on the same graph, the pen color of each variable and associated information shall be displayed in a different color.

   c. Each trend graph shall be capable of displaying a minimum of 15 trend pens with adjustable time base to one second samples and shall be capable of viewing the entire archived trend history.

   d. Possibility to trend multiple pens or multiple plots of the same pen over various time spans for comparison purposes (i.e. previous day to today’s results).

   e. Each pen shall display individual ranges and engineering units. Each pen shall be scalable for display purposes independent to each other pen displayed on a page.

   f. Include the capability to pan backward and forward within a selected time range to read the exact value of any displayed variable, by selecting a point on the graph or
The system shall display historical information as far back in time as desired, with all information being displayed within 1 second.

g. The trend display shall be dynamic, scrolling through time, with the capability to 'replay' or scroll through historical time as well as current time. There shall also be the capability to stop the automatic scrolling of the trend for detailed analysis of a point in history. Pens on the same pane shall be able to be separated both in the time axis and the range axis.

h. The trend display shall have a minimum of 2 slide wire that can be moved over the page. The slide wire will provide indication of the date, time, and value at the intersection of the slide wire and the trend point.

i. The software shall provide "zoom" and "pan" facilities for both the trended variable range and the time axis range. The "zoom" facility shall allow an operator to compress or expand the axis range whilst the "pan" facility shall allow an operator to shift the origin of the axis. The software shall allow a user to define any zoom area by dragging a mouse across the trend.

j. It should be possible to export historical trend data on txt or csv format.

k. The software shall provide the capability of printing out either instantaneous or historical based trends on the designated trend printer. The software shall have the capability to perform a trend print (not a screen print).

I. DEVELOPMENT ENVIRONMENT

1. Description: The development environment is the area that allows generation of graphic screens, alarms screens, tag database, trend screens etc.

2. General Development Environment Functionality: The SCADA software shall include a development environment with the following:
   a. An integrated development package utilizing menu driven, fill in the forms style configuration to develop the runtime system.
   b. All development functions shall be available at every node on the system, and allow multiple users at separate nodes to simultaneously modify the same master database. A minimum of 5 simultaneous developers shall be supported.
   c. Comprehensive on-line help shall be available for all development functions, the on-line help shall contain all information provided in the hard copy manuals.
   d. Provision for back-up or restore an entire database including all graphic displays, configuration data and source code, as well as online configuration (such as menu navigation, trend groups and alarm groups), via a simple point and click method. The backup/restore utility shall prompt the user prior to over writing any existing files.
   e. Ability to create, delete, modify Object Types, ability to create multiple objects, ability to export and import process configuration in CSV format for mass modification, configuration.

J. GRAPHIC BUILDER

1. Description: The graphic builder allows for development of graphic screens.

2. General Graphic Builder functionality: The graphics builder shall be interactive and menu-driven. It shall consist of the following:
   a. Directly import graphics and text in the following file formats:
      1) Windows BMP
2) Windows Meta File WMF
3) GIF
4) TIF

b. The graphics builder shall be capable of creating screens composed of both static and dynamic objects. To create these objects, the software shall provide sample screens and a set of standard shapes in a library. The developer shall be able to include these symbols by reference, or create new symbols/objects.

c. The following Tools:
   1) Grid and guidelines (which can be displayed on screen) together with snap to grid and snap to guidelines to assist in aligning objects precisely.
   2) Horizontal and vertical alignment together with even spacing.
   3) Send to front/back. Bring Forwards one layer, Send backwards one layer.
   4) Bitmap editing including pixel drawing, image resizing, image cropping.

d. "undo" and "redo" feature.

K. CUSTOM SCRIPTING LANGUAGE

1. Description: The scripting language shall be used to develop custom routines, and algorithms not supplied as part of the standard package.

2. Standard Functionality: Scripting shall not be needed to develop any custom code to achieve standard functionality including redundancy failover, recovery and backfilling of historical data.

3. General Custom Scripting Functionality: The SCADA software’s scripting functionality shall include the following.
   a. An integrated high level language specifically designed for SCADA applications that shall be inherently multi-tasking and multi-threading.
   b. Fully integrated and multi-threaded Python scripting.
   c. Access to all field tags, alarms, graphics displays, database and ASCII files. The languages shall include functions with clear and precise syntax. The languages shall support user written functions and function libraries supported by the computer’s operating system. The language shall have the capability to export or import data from other applications.
   d. Creation of calculated (inferred) variables based upon formulae including constants, measured variables and other calculated variables. All facilities available for logging, reporting, trending, monitoring, controlling, alarming and displaying measured variables shall also be available for calculated variables.
   e. Support of mathematical and Boolean operators including:
      i. Addition
      ii. Subtraction
      iii. Division
      iv. Multiplication
      v. AND
      vi. OR
vii. XOR
viii. NOT
ix. Greater Than
x. Less Than
xi. Equal

f. Support for the following mathematical functions:
i. Absolute
ii. Factorial
iii. Floating point sum
iv. Exponent
v. Truncation
vi. Log
vii. Ln
viii. Power
ix. Square root
x. Cos
xi. Sin
xii. Tan
xiii. Arc Cos
xiv. Arc Sin
xv. Arc Tan
xvi. Degree To Radian
xvii. Radian to Degree
xviii. Max
xix. Min
xx. Pi
xxi. Random

g. Prevention of any functions from interfering with proper SCADA functionality.
h. Permit users to create their own functions and integrate them in the language; functions shall be reusable without the need to copy and paste. It shall be possible to call the same function multiple times from different locations, with different parameters simultaneously.
i. Provisions to run functions automatically on start up, on page entry, on page exit, while a page is open, on button down, while button down, embedded in reports, alarm on, alarm off, on any keystroke, any keyboard entry on any mouse button click, etc.

j. Ability to test and debug scripts.

L. REPORTs

1. The reporting module should have following features:
a. Supports Microsoft Excel, PDF for providing reporting output.

b. Mechanism of creating user defined templates for hour, daily, weekly, monthly, yearly & shift-wise report. Also it should be possible to generate report by entering required start and end date-time interval.


d. Provide minimum, maximum, average and sum of any selected tags for selected period.

e. It should incorporate graphics (line, bars etc.) in the report that will be automatically updated in function of the process values for the selected period.

f. Mechanism of avoiding unauthorized access of reports by supporting appropriate user account.

g. E-mailing of reports using SMTP server to selected users.
CHAPTER –G

TECHNICAL SPECIFICATIONS – 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.

Following DG Sets shall be supplied for various Substations:

i. **Substation-1:** 5 Nos. of 2000 KVA (4 Nos of 2000 KVA as working and 1No. 2000 KVA as Standby to be used) Prime Power duty, 3-phase, 50 Hz, 1500 rpm, 415V, Silent Type Diesel Generator Set with suitable batteries, electrical panels, Heat Exchanger Cooling System, Exhaust System (including suitable height of independent steel structure for all DG sets), Day Tank Fuel system, fuel piping etc. as per requirement.

ii. **Substation-2:** 3 Nos. of 1010 KVA (2 No. of 1010 KVA as Working and 1No. 1010 KVA as Standby to be used), Prime Power duty, 3 phase, 50 Hz, 1500 rpm, 415V, Silent type Diesel Generator Set with suitable batteries, electrical panels, Radiator Cooled without Cooling Towers, Exhaust system (including suitable height of independent steel structure for all DG Sets), Day Tank fuel system, fuel piping etc. as per requirement.

The Scope of work shall also include labour, tools, tackles and plants, hardware and consumables, steel fabrication and items as prescribed below:

- Diesel Engine and Alternator set complete with base frame and accessories.
- DG Set shall be with latest Model of PCCM / Synchronizing relay suitable for auto /manual / By pass arrangements.
- 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 and SCADA System.
- Fuel Oil system including day service oil tank, piping, valves, filters etc. from engine to service day oil tank.
- Lube oil system with piping etc. (Pre-lube oil pump with controller if required).
- For DG Sets upto & including 1010 KVA Rating: Radiator Cooled System without Cooling Towers.
- For DG Sets above 1010 KVA Rating: Cooling system with Heat Exchanger, suitable rating Cooling Towers complete with makeup water tanks. Water pumps, GI B class Water Pipes of suitable size with valves, fittings & bends etc shall be provided between DG Sets & Cooling Towers.
- 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.
- Steel fabricated structure/support/hanger including fixing, grouting and bolting etc.
- Painting of steel work.
- LT Termination Box shall be suitable for suitable size Sandwich busducts through flexible tinned copper busbars of suitable ratings.
- Copper Control cabling between DG sets and respective LT Panels
- Exhaust Gas Pipes MS C Class, minimum 6 mm thick with all accessories and hardwares. Height of Exhaust pipes shall be provided as per relevant CPCB and CPWD norms.
- MS Stack structure for supporting DG Exhaust Pipes duly painted with 2 coats of red-oxide primer & enamel paint of approved shade.
- All DG Sets shall be provided adequate shading with polycarbonate sheets supported on MS structure duly painted.
- Body & Neutral earthing of DG Sets complete with earth pits and earth strips/wire etc as per relevant latest CPWD specification.
- All DG Sets shall be certified 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></td>
</tr>
<tr>
<td>Part - X</td>
<td>Test for smoke level, limit and correction for smoke level for variable speed.</td>
</tr>
</tbody>
</table>

| ISO - 3046 | Performance, Torsional vibrations. |

<table>
<thead>
<tr>
<th>(C) IS 4889/BS - 269</th>
<th>Alternator</th>
</tr>
</thead>
<tbody>
<tr>
<td>For declaring efficiency of electrical machines.</td>
<td></td>
</tr>
</tbody>
</table>

| IS 4722 -1992 | Capability of machine to withstand over current / overload. |

<table>
<thead>
<tr>
<th>IS-13364 Part I 1992</th>
<th>Alternator - Voltage Regulations upto 20 KVA</th>
</tr>
</thead>
</table>

| IS-13364 Part II 1992 | Alternator - Voltage Regulations above 20 KVA to 80 KVA |
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 -5°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 oversizing 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 conform 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 slencer 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. The successful bidder will submit GFC drawings 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 cooled 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 12V/24V DC comprising of suitable batteries, Voltage Regulator and arrangement for initial charging of batteries.

Bed Plate:-

The bed plate shall be fabricated from M.S. channel. The welding shall be radio graphed, 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.

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.

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.

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.

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.

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.

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.

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.

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.

Exhaust Manifold:-

The exhaust manifold shall be multi-branch, of insulated design utilizing Ni-resist casting.

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.

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.

9. **HEAT EXCHANGER**

The DG Set should be equipped with a Heat Exchanger/ Radiator for suitable continuous duty operation.

10. **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
- Over speed

11. **OTHER AUXILIARY EQUIPMENT/SERVICES**

These shall be complete include the following:-

i. Silencer

Exhaust Silencer shall be residential type to reduce the noise level. Values for Pressure drop across the silencers to be indicated by the Contractor.
ii. 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.

12. 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.

13. 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.

14. 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.

15. 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.

16. 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.

17. **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 Barings 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%.

18. **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 or on SCADA network. 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.

19. **EXHAUST PIPING**

**Exhaust Piping:** The exhaust silencer piping system shall be of heavy duty MS, Class-C pipes, 6 mm thick minimum. 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.

20. **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

**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.

**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.

21. **Battery/ Electrical System**
Batteries supplied with Genset are generally dry and uncharged. Initial charging should be done for 72-80 hours. Batteries shall be placed on MS 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>2 x 180 AH</td>
<td>70</td>
<td>2 x 12 V</td>
</tr>
<tr>
<td>Above 125 KVA upto 500 KVA</td>
<td>1 x 180 AH</td>
<td>70</td>
<td>12 V</td>
</tr>
<tr>
<td>Above 82.5 KVA upto 125 KVA</td>
<td>1 x 180 AH</td>
<td>50</td>
<td>12 V</td>
</tr>
<tr>
<td>Above 62.5 KVA upto 82.5 KVA</td>
<td>1 x 150 AH</td>
<td>50</td>
<td>12 V</td>
</tr>
<tr>
<td>Above 25 KVA upto 62.5 KVA</td>
<td>1 x 120 AH</td>
<td>50</td>
<td>12 V</td>
</tr>
<tr>
<td>Upto 25 KVA</td>
<td>1 x 100 AH</td>
<td>35</td>
<td>12 V</td>
</tr>
</tbody>
</table>

Note: 1 Set of spare batteries shall be provided in parallel along with each DG Set in addition to the batteries mentioned in the Table above.

i. Cabling & Bus Trunking-

Power cabling between alternator to Main LT Panel shall be carried out as per recommended cable sizes upto DG set of capacity 750 KVA.

For DG Set of capacity 750 KVA & above, connection between alternator to Main LT Panel shall be through Sandwich bus trunking unless stated otherwise. For exposed/ outdoor bus trunking protection requirement should be IP-66.

While terminating cables, any tension on the bolts/ busbars shall be avoided (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.

ii. 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.
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 trials 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.

22.1. TRIALS (AT SITE):

i. 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.

ii. 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.

22.2. 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.

23. COOLING TOWERS AND WATER CIRCULATING EQUIPMENT

23.1. GENERAL

The various items of the water circulating system shall be complete in all respect and comply with the specification given below. The total sound intensity with all fans in operation shall not
practically exceed noise levels as prescribed in CTI, CPWD and other relevant norms, from all around the cooling towers.

23.2. COOLING TOWERS (FRP CONSTRUCTION)

The cooling towers shall be of FRP, Vertical induced draft type complete with FRP basin FRP body, fan and motor assembly, fill media, distribution pipes etc.

23.3. GENERAL CONSTRUCTION

The body shall be made of FRP (Fibre glass reinforced plastic) section of equal segments, all bolted together. The surface on both inside and outside shall be smooth, for minimum air resistance. The fan deck shall form an integral part of the body. The structural strength of the body shall be sufficient to withstand wind velocities upto 60 m/sec. Vibrations and earth quake.

The water basin shall also be of FRP. Having an auxiliary suction tank, at the bottom. The basin shall be complete with conections for drain, overflow, makeup water, quickfill and float valve, plus hot dipped galvanized stainer.

The support structure for the tower shall be of mild steel duly hot dipped galvanizated. The water diffusion deck shall of rigid PVC fill in Honeycomb design, arranged in a suitable pattern for ease of replacement. PVC fills shall be of high efficiency. The colour of the cooling tower body shall be of the owner / architect choice.

23.4. COOLING TOWER CAPACITIES:

The cooling towers of adequate capacity along with suitable size make up water tank shall be installed at the terrace of the substation buildings from where the common header of the cooling towers shall be brought down to the DG Sets. Soft water is required to be filled up in Makeup water tank for closed circuit cooling of DG Set engine. The contractor shall obtain the required data from the manufacturers (OEM) of DG Sets for calculating the cooling tower capacity for smooth operation of the DG sets.

The inlet temperature to the cooling tower shall be of 43.3 degree C or as per design requirements. The inlet temperature from cooling tower shall be of 32.3 degree C or as per design requirements.

Individual Cooling Towers of suitable capacity shall be provided for continuous operational duty of each DG Set. Likewise, individual Water Pumps along with standby spare pump of suitable capacity for Cooling Towers’ operation shall be provided for each DG Set. The size of common headers and water pipes for cooling towers shall be designed as per operational requirements. The common headers and water pipes for cooling towers shall have temperature gauges, pressure gauges, Butterfly valves, Non return valves, fittings and all other instruments as required.

23.5. WATER DISTRIBUTION SYSTEM

The hot water shall be distributed through a sprinkle system consisting of PVC sprinkler pipes, which shall be mounted on the top of the main supply stand pipe. Each cooling tower shall have twin header system coupled with gravity flow distribution system.

23.6. FAN ASSEMBLY

The fan shall be of axial flow type with cast aluminium multiple blades of aerofil design and adjustable pitch. The fan assembly shall be statically balanced. The fan outlet velocity shall not be less than 10 m/ s and the tip speed shall be below 4500m/ minutes.

The fan shall be directly mounted on the motor or through speed reduction gears. In the latter case, the housing shall be of heavy cast iron, construction with large oil reservoir.

The fan motors shall be totally enclosed fan cooled squirrel cage type confirming to IP 55 Protection for outdoor operation.
The fan guard shall be hot dipped galvanized with wire mesh screen to prevent bird nesting during idling period.

23.7. LADDER
All towers, whose height exceeds 2.5 mtrs, shall be provided with a ladder, made out of hot dip galvanized MS Tubes.

23.8. PUMP SETS
The pump sets shall be mono block type with end suction and top discharge flanged connections directly mounted on the dripproof squirrel cage induction motors and suitable starter as specified.

The impeller shall be of Bronze, single enter shrouded design, and properly balanced. Water seal shall be of mechanical type to minimized water leakage and should be easily serviceable in the field.

Motor and starter shall confirm to relevant specifications and of rating as per DBR / Drawings.

23.9. MISCELLANEOUS
The following items to be provided:

- Water pressure gauge at inlet and outlet of each pump complete with gauge cocks and connected tubing.(To be priced separately)
- Vibration isolation pads for each pumps.
- Drain line from each pumps up to drain pit, (priced separately).

23.10. INSTALLATION AND TESTS
The cooling towers shall be mounted on the beam/ steel structure member, provided by Contractor and shall be unconnected with the roof slab. All nuts / bolts etc. for mounting shall be provided by the Contractor.

On installation of the capacity of the cooling towers shall be checked by measuring water flow rate, water IN and OUT temperature and the ambient W.B. Temperature and then computing the capacity and efficiency.

The pumps sets shall be mounted on cement concrete foundation which shall be provided by HVAC contractor including grouting nuts, bolts, channels etc. shall be provided by the contractor.

On installation the capacity of the pumps shall be checked by measuring water flow. Motor current and pressure difference at inlet and outlet. The reading shall be recorded to compare actual performance with the specified data. Magnetic level switches shall be provided for low level alarm, in each cooling tower.

23.10.1. PIPE WORK
i. General:
All piping work shall confirm to quality standards and shall be carried out as per specifications and details given hereunder:

ii. Pipes:
All pipes in sizes 200 shall M.S. E.R.W. tube (black steel) heavy class as per I.S. 1239-79, Part -1 with amendment-1. All pipes above 150 mm dia. shall be minimum 6.4 mm thick.

iii. Fittings:
The dimensions of the fittings shall conform to I.S. 1239/69 Part-II unless otherwise indicated, in the specifications.
All bends in sizes up to and including 150 mm dia., shall be ready, made of heavy duty, wrought steel of appropriate class.

All bends in sizes 200 mm and larger dia., shall be fabricated from pipes of the same dia and thickness, with a minimum of 4 sections, and having a minimum centre line radius of 1.5 diameter of pipes.

All fittings such as branches reducers etc. in all sizes shall be fabricated from pipes of the same dia. And thickness and its length should be at least twice the dia. of the pipe.

The branches may be welded straight to the main line without making a separate fitting, where specified on drawings or required by engineer-in-charge.

Blank ends are to be formed with flanged joints and 6 mm thick blank between flange pair for 150 mm and over, in case where, a future extension is to be made otherwise bland and discs of 6 mm thickness are to be welded on, with additional cross stiffeners from 50mm x 50mm M.S. Heavy angles, for sizes up to 350mm. All ends larger than 400 mm dia. shall have dished ends.

iv. Flanges.

All flanges shall be of mild steel as per I.S. 6392/71 and shall be steel slip-on-type, welded to the pipes, flanges thickness shall be to suit class-II pressures.

Flanges may be tack welded into position, but all final welding shall be done with joints dismounted. 3 mm thick gaskets shall be used with all flanges joints. The gaskets shall be filler reinforced rubber as approved by the Engineer-in-charge. Special adhesive compound shall be used between flanges of steam, air and gas lines.

Flanges shall be used as follows:-

- Counter flanges for equipment having flanges connections.
- Flanged pairs shall be used on all such equipment, which may require to be isolated or removed for service e.g. Pumps, refrigeration machines air handling units etc.
- All thread valves shall be provided with nipples and flanged pairs on both sides to permit flange connections, for removal of valves from main line for repair/replacement.

v. Valve:

a) Butterfly Valves

The butterfly valve shall consist of cast iron body preferably in two piece construction.

The discs shall consist of disc pivot and driving stem shall be in one piece centrally located.

The valve seat shall be synthetic material suitable for water duty. It shall line the whole body.

The discs should move in slides bearing o both ends with ‘o’ ring to prevent leakage.

The handle should have arrangement for locking in any set position.

All gate valves and check valves up to 65 mm dia. shall be of gunmetal screwed type, conforming to class 2 of I.S. 778. and shall be with I.S.I marking and certification.
All gate valves and check valves up to 80 mm dia. and above shall be of cast iron flanged type, conforming to class 2 of I.S. 780/69 (for sizes up to 350 mm) and of I.S. 2906/69 (for sizes 350 mm and above) marking and certification.

All gauge cocks shall be of gunmetal plug type, complete with siphon (brass chrome plated).

All drain valves shall be of gunmetal with a hose union connection of one hand.

All valves on the supply of fan coil units shall be of gunmetal ball type with integral water strainers, having (BSP) fpt inlet and flare type MPT outlet connection.

All valves on the return line of fan coil units shall be as in 5.6 but without integral water strainer.

b) **Balancing Valves** :

The balancing valves up to 80 mm dia. shall be of gunmetal screwed type confirming to B.S. 5154 or equivalent specifications.

The valves shall be cast gunmetal ASTM B-62 and complete with non rising spindle. PTFE disc seal cast metal hand wheel.

The port opening shall permit precise regulation of flow rate, by accurately measuring the pressure drop across the port.

The valves shall be complete with two ports for connection to a mercury manometer, to measure the pressure drop, as well as a drain port.

The spindle shall have shielded screw to set the flow at the desired level.

The valves shall be used wherever specified.

c) **Strainers** :

The strainers shall either be pot type or ‘Y’ type with cast iron or fabricated steel body, tested up to pressure applicable for the valves as shown on the drawings.

The strainers shall have a perforated bronze sheet screen with 3 mm perforation and with a permanent magnet, to catch iron fillings.

Pot strainers shall be provided with flanged connection and ‘Y’ strainers shall be provided with flanged ends.

The strainers shall be designed to facilitate easy removal of filter screen for cleaning without disconnection of pipe line.

d) **Jointing**

All pipes line shall be welded type.

Square cut plain ends will be welded for pipes up to and including 100 mm dia.

All pipes 125 mm dia or larger will be beveled by 35 deg before welding.

e) **Miscellaneous** :

Provide all pipe work as required to make the apparatus connection complete and ready for regular and safe operation. Unless otherwise noted, connect all apparatus and equipment in accordance with manufacture’s standard details, as approved by Engineer-in-charge.

Unless otherwise specified, pitch the lines of piping as follows:-
• All condensation drainage, including air handling unit and fan coil unit shall be pitched in the direction of flow to ensure adequate drainage, with an adequate trap seal to prevent leakage of air due to static pressure developed by air conditioning units. Pitch, 20 mm per meter wherever possible, but not less than 10 mm per meter.

• Drains from other equipments shall be pitched similarly without trap seal.

• Provide valves and capped connections for all low points in piping system, where necessary or required for draining system. Provide isolating valves & drain valves in all risers to permit repairs without interfering with the rest of the system.

• Support piping independently of all equipment so that the equipment is not stressed by the piping weight or expansion.

• To facilitate the maintenance, repair and replacement.

• Provide shut-off valves where indicated and for individual equipment, units at inlet

• And outlet, to permit unit removal for repairs, without interfering with the remainder of

• The system. Additional shut-off valves shall be provided as required to enable all systems

• to be fully sectionalized. By-pass and stop valves shall be provided for all automatic

• control valves as specified.

• Arrange piping for maximum accessibility for maintenance and repair, locate valves

• for easy access and operation. No valves shall be installed with handles pointing down, unless unavoidable.

• Cut the pipes accurately according to measurements, established site & work into phase without springing or forging.

• Pipe supports shall be adjustable for height and prime coated with rust preventive paint & finish coated with grey paint, both as approved by engineer-in-charge. The spacing of

• Pipe supports shall not be more than that specified below:-

<table>
<thead>
<tr>
<th>Nominal pipe size (mm)</th>
<th>spacing (meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>1.25</td>
</tr>
<tr>
<td>20,25</td>
<td>2.00</td>
</tr>
<tr>
<td>32,30,50,&amp;65</td>
<td>2.50</td>
</tr>
<tr>
<td>80,100,&amp;125</td>
<td>2.50</td>
</tr>
<tr>
<td>150&amp;Above</td>
<td>3.00</td>
</tr>
</tbody>
</table>

Extra supports shall be provided at the bends and at heavy fittings like valves to avoid undue stresses on the pipes. Pipe hangers shall be fixed on walls and ceiling by means of metallic approved dash fasteners.
Insulated piping shall be in such a manner as not to put undue pressure on the insulation, such as providing teak wood block between pipe and support.

Where pipes are to be buried under ground, they should be coated with one coat of bituminous paints. The top of the pipes shall not be less that 75 cms. From the ground level. Where this is not practical permission of engineer-in-charge shall be obtained for burning pipes at lesser depth. The pipes shall be surrounded on all sides by sand cushion of not less than 15 cms. After the pipes have been laid and top sand cushion proved, the trench shall be refilled with the excavated soil, excess soil shall be removed from the site of work by the contractor.

f) **Hangers & Supports**:

Hangers & supports shall be provided and installed for the piping and tubing wherever indicated, required or otherwise specified. Wherever necessary, additional hangers and support shall be provided to prevent vibration or excessive deflection of piping and tubing.

All Hangers & supports shall be made of steel or other durable and non-combustible material, given two coat of primer red oxide and then painted with aluminium colour paint. Wood wire or perforated strap iron shall not be used as permanent hangers or supports.

Hangers shall be supported from structural steel, concrete inserts & pipe racks, as specifically approved.

No hangers shall be secured to underside of light weight roof decking and light weight floor glass.

Mechanical equipment shall be suspended midway between steel joists and panel points.

Drilling or punching of holes in steel joist members will not be permitted.

g) **Sleeves**:

Where pipes pass through floors, walls, etc provide Galvanized steel pipe sleeves 50 mm larger than outside diameter of pipe. Where pipes are insulated, sleeves shall be large enough to ample clearance for insulation.

Where pipes pass through outside walls or foundation, the space between pipe and sleeve shall be caulked with lead wool and oakum.

The centre of pipes shall be in the centre of sleeves, and sleeves shall be flush with the finished surface.

h) **Expansion or Contraction**:

The contractor shall provide for expansion and contraction of all piping installed by the use of swing connection and expansion loops.

i) **Arrangement and alignment of Piping**:

All piping shall be arranged and aligned in accordance with the drawings as specified. Where special conditions are encountered in the field, the arrangement and alignment of piping shall be as directed by the engineer-in-charge. The piping shall be installed in a uniform manner, parallel to or perpendicular to walls or ceiling, and all changes in directions shall be made with fittings. The horizontal piping shall be run at right angle and shall not run diagonally across
rooms or other piping. Wherever possible all piping shall be arranged to provide maximum head room.

All piping shall be installed as directly as possible between connecting points in so far as the work of other trades permits. Where interference occurs with another trade whose work is more difficult to route, this contractor shall reroute his pipes as required to avoid interference, at the discretion of the engineer-in-charge.

All piping shall be carefully installed to provide for proper alignment, slope and expansion.

The stresses in pipe lines shall be guided and pipes shall be supported in such a manner that pipe lines shall not creep, sag or buckle.

Anchors and supports shall be provided wherever necessary to prevent any misalignment of piping.

Small tubing gauges, controls or other equipment installed on any apparatus, shall not be coiled nor excessive in length, but shall be neatly, carefully bent at all change in direction, secured in place and properly fastened to equipment at intervals to prevent sagging.

The piping shall be grouped wherever practical and shall be installed uniformly in straight parallel lines in either vertical or horizontal positions.

j) Testing:

In general, tests shall be applied to piping before connection of equipment and appliances. In no case shall the piping, appliance be subjects to pressures exceeding their test ratings.

The tests shall be completed and approved before any insulation is applied. Testing of segments of pipe work will be permitted, provided all open ends are first closed, by blank offs or flanges.

After tests have been completed the system shall be drained and flushed 3 to 4 times and cleaned of all dust and foreign matter. All strainers, valves and fitting shall be cleaned of all dirt, filling and debris.

All piping shall be tested to hydraulic test pressure of at least one and half times the maximum operating pressure but not less than 10 kg/sq. cm for a period of not less than 12 hours. All leaks and defects in the joints revealed during the testing shall be rectified to the satisfaction of the engineer-in-charge, without any extra cost.

All the piping system shall be tested in the presence of the engineer-in-charge or their authorized representative. Advance notice of test dates shall be given all equipments, labour, materials required for inspection, and repairs during the test shall be provided by the contractor. A test shall be repeated till the entire systems are found to be satisfactory to the above authority. The tests shall be carried out for a part of work if required by engineer-in-charge in order to avoid hindrance in the work of the insulation contractor.

All steam and condensate pipes shall be tested and proven tight under hydrostatic pressure of 20 kg/sq.cm, unless otherwise stated, for a minimum period of 4 hours without drop in pressure.

Miscellaneous piping, tests with air at 10.5 kg/sq.cm for a minimum of 24 hours without drop in pressure.

k) Painting:
All pipes supports, hangers, etc, shall be given two coats of red oxide primer.

All pipes, which are not to be insulated, shall then be given one or more coat of red oxide primer along with two or more coat of finish paint, of a type and colour, as per relevant IS code.

24. EXHAUST PIPING

The Exhaust piping system for the DG Sets shall be as per CPWD Specifications meeting the requirements of CPCB Norms. The exhaust silencer piping system shall be of Heavy Duty Class C, MS pipes confirming to IS-3589. 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 clad 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.

25. 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 Contractor 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 Set). The PLC for the further operation shall be mounted on the Synchronizing panel with SLC 5/03 processor, kw transducer & suitable input /out put 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 convertor, communication cable.

Alarms and necessary remedial commands for D.G. and electrical system fault.

- D.G synchronizing panels .

For Local Control and Manual Synchronization, the minimum instrument/equipment shall be as follows:

- DG selector switch
- PLC / manual selector switch
- Double scale voltmeter
- Double scale frequency meter
e. Synchronoscope
f. Check synchronization relay
g. Synchronization lamps
h. Solo parallel selector switch
i. Manual synchronization circuit “ON”/”OFF” selector switch
j. Push buttons & indicating lamps
k. Control PT
l. 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:
   (i) Each phase indication (for all 3 phases)
   (ii) D.G breaker ON, OFF, TRIP, Spring charged
   (iii) Neutral contactor “ON”/”OFF”
   (iv) Engine running
   (v) Battery charger “ON”
   (vi) Control supply healthy
   (vii) Priming pump “ON”/”OFF”
g. Speed raise / low joystick
h. Voltage raise / low joystick
i. 12 window annunciator with alarm Accept/Test/Reset push buttons, Hooter.
j. Temperature Scanners for RTD and BTD
k. Beacon light
l. Hour meter
m. Under voltage relay for mains feeder
n. Over Voltage relay for mains feeder
o. Earth fault relay
p. Reverse power relay (reactive)
q. Trip circuit supervision relay
r. Master trip relay
s. 5 H.P, DOL starter for oil priming pumps for D G Set
t. Power factor meter (Analog)
u. Frequency meter (Digital)
v. Ammeter (Digital)
w. Voltmeter (Digital)
x. Multi function meter (Digital)
y. D.C. Ammeter (digital)
z. D.C. Voltmeter (digital)

aa. Breaker Control Switch for bus coupler
bb. Battery Charger on / off switch with boost and trickle charger facility
cc. Trickle / booster charger selector, switch
dd. Push buttons (lot)
e. P.
 ff. Aux. Contactor (lot)
g. Transducers

25.1. 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.

25.2. 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.
- Synchronus check relay 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
- Voltage unbalance
- Mains Protection (vector shift, df/dt)
- 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
o Power monitor to monitor voltage, KVA, KVAR, KW, KWH, KVAH, KVARH.
o 16/32 channel Digital input module
o 16/32 channel Digital output module
o EEPROM for main processor unit
o Computer to PLC communication card with necessary cables.
o Window based operator interface Software Package
o 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.
o 1 No. 2 slot extension rack
o 1 No. Ram back up battery unit
o 8/4 Nos. digital input module
o 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.

25.3. 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 with necessary control wiring between cooling tower, pumps and PLC panel.

25.4. SYNCHRONIZING MODULE

The synchronizing module shall be a microprocessor based intelligent unit, which shall monitor the electrical parameters and shall be able to communicate 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 back 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 and controlling shall be through a PC based SCADA station.

26. BULK HSD OIL STORAGE, PUMPING & TRANSFER SYSTEM

26.1. General

It is proposed to provide 2 X 20 KL HSD UG Tanks at AIIMS campus. The scope of work required to be covered under this package comprises of supply, installation, testing & commissioning of the underground HSD Tank, HSD Pumps, HSD Pipes and facilities including obtaining all permissions from authorities and providing safety/protection measures for eventuality such as breach/leakage in accordance with the requirements broadly given in the EPC Tender, specifications, technical data. The work shall be carried out with high level of workmanship and respecting requirements of other services and aesthetical requirements. The EPC Contractor shall be responsible for getting approval of all the drawings from relevant Statutory bodies before execution at site.

For efficient and uninterrupted fuel supply to all DG Sets, Bulk High Speed Diesel (HSD) Oil Storage with fuel transfer/ pumping system shall be designed & installed. For this purpose, suitable capacity underground Bulk Oil (HSD) storage tanks with dished ends conforming to IS 10987 – 1992 provided with all standard appurtenances/ mountings like hinged cover manholes, access ladders, lifting lugs, earthing terminals, filling & suction arrangement, overflow connection, vent pipe, dip stick, level gauge etc. complete in all respect as per relevant specifications. Tank & dished ends shall be fabricated from required thickness MS plates.

Anti-rust protection for oil tanks shall be provided. Earth excavation, back filling, levelling, compaction, dressing etc. shall be done. Suitable concrete bed & RCC pedestals shall be provided for tank installation. Adequate capacity fuel transfer pump sets (working & standby) with rotary gear pumps and flameproof electric motors shall be provided for auto & Manual both transferring HSD oil from underground bulk storage tank to 990 Liters buffer oil tanks of DG Sets. For oil transfer, MS C Class oil pipes of suitable diameter and thickness, required bends, supports, clamps etc. shall be provided. Anti-rust protection for pipes like primer paint, Pypekote etc. shall be adequately provided. Oil pipes shall be provided with ball valves, strainers, mesh, oil flow meters, foot valve, check valves, pressure gauges, siphon & gauge cocks etc. Electronic level
controller cum sensor with high & low level probes shall be provided in oil buffer tanks for automatic operation of fuel transfer pumps. Outdoor type flameproof electrical panel with suitable rating incoming & outgoing feeders shall be provided. Smoke & danger sign boards with fire buckets shall be provided.

Necessary approvals from the concerned Explosives Authority shall be obtained by the contractor.

The Contractor shall carry out and completes the said work under this contract in Every respect in conformity with the rules and regulations of the Local Authority. The contractor shall furnish all labour, supply and install all new materials, appliances, equipment necessary for the complete provision and testing of the complete Fire Fighting services installation as specified herein and in accordance with relevant BIS codes and as shown on the drawings. This also includes any material, appliance, equipment not specifically mentioned herein or noted on the drawings as being furnished or installed but which are necessary and customary to make a complete installation. In general the work to be performed under this contract shall comprise of the following:

The equipment and items to be furnished under the scope of this contract are broadly outlined there in after. Any additional equipment, material, services which are not specifically mentioned but required to make the system complete and acceptable & shall be deemed to be included in the scope.

Scope of work interalia covers:

- Supply, Installation, testing, commissioning, handing over to Client the complete infrastructure as per specification and as per latest edition of National Building code/relevant applicable bye laws and authority requirements

- Transportation to site, unloading and intermediate storage at site, complete work of erection including final grouting, testing and commissioning and putting into operation of entire system of storage & supply along with Fire safety measures.

- Supply of various drawings, data, test reports, test certificates, operation and maintenance manual as necessary. Soft copy (pdf & auto cad) of as built and approved drawings should also be provided.

- First fill of all fuel and lubricants. All spare parts and tools and tackles as per specification.

- All final dressing of foundations, grouting of equipment, patch work during and after erection excavation for laying of underground piping, back filling, dressing, compacting, watering, other allied works etc. complete as per manufacturer’s specifications & directions of Engineer-In-Charge is included in the scope of work & nothing extra shall be payable on this account.

- The Contractor will obtain No objection certificate/Permissions from Local Administration/Authorities, Chief Controller of Explosives, Nagpur and other statutory bodies as required before commencement of works and after completion of works as required.

The cost incurred for covering complete scope of works specified as above shall be included in the financial bid.

All incidental jobs connected with installation such as excavation of trench and back filling, cutting & welding work, cutting/ drilling holes through walls, floors and grouting for fixing of fixtures, equipment foundation, Structural supports & other supports as required at site shall be part of the work.
Contractor shall submit the samples/catalogues of each material/equipment giving technical data. Only after written approval of samples/catalogues, the Contractor shall place the order.

Preparation of shop drawings - Contractor shall submit the detailed GFC drawings after coordinating with structural, architectural / PMC and other services drawings for piping, structural arrangements etc. All structural openings & pipe sleeves shall be identified. Shop drawing shall be furnished as when required.

Before starting the work at site the Contractor shall examine all services drawings and report to Consultant for discrepancies and obtain clarifications. Any work done without regard for consultation with other trades, shall be removed by the contractor without additional cost to the owner.

All items must include all accessories fittings as described in the specifications and cover all items required to make the system fully functional but not limited to:

26.2. Piping Work

Suction and delivery headers for each pumping system shall be as per DBR/ drawings. Piping work shall include all fittings, flanges, jointing, clamps for fixing to walls or hangers, painting and testing. Flanges shall include 3 mm thick insertion rubber gasket, nuts, bolts and testing.

Water Tank, Vibration eliminators, "Y" strainers, butterfly valves, slim non return valves shall be as per DBR/ drawings.

27. HSD Tank & Storage System

<table>
<thead>
<tr>
<th>S.No</th>
<th>Description</th>
<th>Supply fabrication</th>
</tr>
</thead>
</table>
| 1.   | 2 X 20 KL Gross CAPACITY HORIZONTAL CYLINDRICAL MILD STEEL STORAGE | IS : 10967  
Shell / ends: 6/10mm  
Painting: RO primer  
2 coats of shalimastic tank primer in U/G position after testing 1mm / 40 micron DFT  
Testing Hydrostatic at 5psig  
End ring as per code  
Manhole, bends, suction, delivery nozzles with class 150 flanges & IS 12399 (Part—I)'M' pipe nozzles  
Shroud plates 8mm. |
| 2.   | Installation | As per drawing,  
RCC strip raft, anchored tank , side wall in BM 1:4 complete RCC slab design + top soil load = buoyancy load of 40mt in RCC M-20 |
<p>| 3.   | MS pipeline | IS-1239 Part-I MS C Class black |
| 4.   | Hose | 80mm NB , steel braded , flanged and screwed end. |
| 5.   | Coating of U/G pipeline | AWWA in standard integrated 3 layer covering insprial ratio 1:1 |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6.</td>
<td>Flanges</td>
<td>ANSI B-16.5 class 150 raised face serrated in 10% less thickness from code thickness</td>
</tr>
<tr>
<td>7.</td>
<td>Nuts / Bolts</td>
<td>Half thread Hexagon head</td>
</tr>
<tr>
<td>8.</td>
<td>Gasket</td>
<td>3mm Compressed asbestos fibre gasket</td>
</tr>
<tr>
<td>9a.</td>
<td>Valves</td>
<td>3 pieces ball valves threaded / flanged</td>
</tr>
<tr>
<td>9b</td>
<td>Solenoid Valve</td>
<td>25mm, 40mm, 50mm</td>
</tr>
<tr>
<td>10.a</td>
<td>Fittings</td>
<td>Heavy duty schedule 40</td>
</tr>
<tr>
<td>10.b</td>
<td>Gauge glass Indicator</td>
<td>Reflex type</td>
</tr>
<tr>
<td>11</td>
<td>Pump</td>
<td>Screw gear pump flanged end, Screwed I/O 40mm / 40mm</td>
</tr>
<tr>
<td>12</td>
<td>Motor</td>
<td>Flame proof rating up to 3 hp 1440 rpm 415 volts 3ph IS:2148 CCE / CMRI approved</td>
</tr>
<tr>
<td>13</td>
<td>Starter</td>
<td>Flame proof DOL starter, Non flame proof / push button station</td>
</tr>
<tr>
<td>14</td>
<td>Cables</td>
<td>XLPE insulated &amp; armoured as per IS: 7098</td>
</tr>
<tr>
<td>15</td>
<td>Glands</td>
<td>Double compression FLP / Non flame proof</td>
</tr>
<tr>
<td>16</td>
<td>Level switches</td>
<td>Reed type calibrated level at 2/ 4 % levels. With % reading of stock level close to pumps or on control panel</td>
</tr>
<tr>
<td>17</td>
<td>MS structural</td>
<td>ISA 40x5 to ISA 75x8 ISMC 150</td>
</tr>
<tr>
<td>18</td>
<td>Control Panel</td>
<td>Triple layer protective coating , 14 G MS sheet enclosure indoor service floor / wall mounting as per approval of consultant With indicating lamps VM, AM, VSS, ASS, indicating lights DOL starter ,push buttons ,% Digital level indicators, auto manual selector switches</td>
</tr>
<tr>
<td>19</td>
<td>Dipstick</td>
<td>20mm square drawn Al. rod graduated in 2mm intervals with lifting hook..</td>
</tr>
<tr>
<td>20</td>
<td>Flow meter</td>
<td>I/O–80mm positive displacement type 40 lph OR 1/O— 50 mm ...............do........ 40 lph. 1/O—25mm ...............do........ ....20 lph</td>
</tr>
<tr>
<td>21</td>
<td>Strainer</td>
<td>Basket, CS body , flanged to class 150, SS-40 mesh internal</td>
</tr>
<tr>
<td>22</td>
<td>Paints</td>
<td>Only colour Red oxide primer &amp; Enamel 1st quality</td>
</tr>
<tr>
<td>23</td>
<td>Level switch</td>
<td>4 level progressive read switch bar</td>
</tr>
<tr>
<td>24</td>
<td>Pressure gauge</td>
<td>100mm dial - rating 0 to 10 kg/cm</td>
</tr>
<tr>
<td>25</td>
<td>Flame arrestor</td>
<td>Suitable for lorry tanker exhaust CCE approved.</td>
</tr>
</tbody>
</table>
CHAPTER –H

TECHNICAL SPECIFICATIONS – FIRE ALARM & PUBLIC ADDRESS SYSTEM

1. 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 specified herein.

b. The fire alarm system shall comply with requirements of IS:2189:1999 & 1996 NFPA Standard 72 for Protected Premises Signalling 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 for equivalent European standard EN54.

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 FACPs 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.

1.1. SCOPE:

a. A new network intelligent reporting, microprocessor controlled fire detection and shall be compatible with PA system emergency voice alarm communication network shall be installed in accordance with the specifications and drawings.

b. Basic Performance:

i. 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.

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

iii. Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D). Connected by the SLC.

iv. Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z). Connected by the SLC.
v. 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).

vi. 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.

vii. 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.

viii. Digitized electronic signals shall employ check digits or multiple polling.

ix. 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.

x. 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.

1.2. 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.

1.3. 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: / EN - 54

C. NBC - 2016 (Part-4)

D. All requirements of the Authority Having Jurisdiction (AHJ).

1.4. APPROVALS:

A. The system must have proper listing and/or approval from any of the following recognized agencies:

UL - Underwriters Laboratories Inc
FM - Factory Manual
ULC - Underwriters Laboratories Canada
CPWD - Central Public Work Department
BIS - Bureau of Indian Standards

EN 54 or Equivalent European 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.

1.5. EQUIPMENT AND MATERIAL:

1.5.1. 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.

1.5.2. WIRE & Cable

Fire Survival Cable: For the detector and sounders proposed to fixed on false ceiling/surface, the wiring shall be done with Fire Survival Cable capable of withstanding temperature up to 950 degree C for 20 minutes and 650 degree C for the 180 minutes. The fire survival cable shall be laid on surface with proper saddle etc. or per requirement & in cable tray above false ceiling. The cables may be armoured/unarmoured as per the location of use.

Wire: Fire alarm system wiring to be carried out with 1.5 mm² PVC insulated copper conductor cable for detectors and sounders and the conduit for the same have to be embedded in the ceiling.

Wiring shall be in accordance with CPWD specification (Electrical )-2013. 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.

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.

1.6. FIRE ALARM CONTROL PANELS AND FIRE CONTROL ROOM:

The Fire Alarm Control Panel shall be as per IS: 2189 (latest amended). 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 640-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.
   d. Printing and history storage equipment shall log the information associated with the fire alarm control panel condition, along with the time and date of occurrence.
   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.

1.7. General FACP Configuration & Operation
   a. Each FACP node shall include a full featured operator interface control and annunciation panel which shall include a backlit 640 character Liquid Crystal Display (LCD), individual, color coded system status LEDs, and an alphanumerical keypad for field programming and control of the node.
   b. 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.
   c. 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.
   d. 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.
e. 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.

f. 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.
   i) 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.
   ii) 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
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>Loop cards as per floor requirement</td>
</tr>
</tbody>
</table>
| Compatibility | Photo electric smoke sensors  
| | Loop isolators  
| | Loop sounders  
| | Loop manual call points  
| | Loop input monitoring cards  
| | RS 485 cards for networking & RS 232 cards for printer & CRT  
| | Convention devises |
| No of devices | Each loop shall be able to cater to minimum as per IS or manufacturer standard |
| Operation Voltage | 15 V to 28 V DC, 3 amps |
| Input Voltage | 230 V AC, 1 Ph 50HZ, 0.75 amps. |
| Standby battery charging | 28 V DC, 1.5 A |
| Wiring/ Cabling | 2 core 1.5 mm², copper, PVC insulated, twisted, screened Fire survival armored cable or 2 core 1.5 mm², copper, PVC insulated, twisted, screened flexible cable in concealed MS conduits. |
| Loop wire monitoring | Open circuit  
| | Short circuit  
| | Earth Leakage  
| | Device removed  
<p>| | Wrong Device |
| Communication | To remote repeater panel through proprietary protocol over RS 485 link |
| Outputs | 2 X programmable sounders on panel |</p>
<table>
<thead>
<tr>
<th><strong>Tell No.</strong></th>
<th>HITES/AIIMS-Guwahati/2018</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Printer</strong></th>
<th>24 character built in printer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Communication port</strong></td>
<td>RS 485</td>
</tr>
<tr>
<td></td>
<td>RS 232</td>
</tr>
<tr>
<td><strong>Selectable Features</strong></td>
<td>Common sounders</td>
</tr>
<tr>
<td></td>
<td>coincidence alarm</td>
</tr>
<tr>
<td></td>
<td>RMC Fire</td>
</tr>
<tr>
<td></td>
<td>RMC Fault</td>
</tr>
<tr>
<td></td>
<td>Zone walk test</td>
</tr>
<tr>
<td></td>
<td>Control Output</td>
</tr>
<tr>
<td></td>
<td>Output delay Alarm counter</td>
</tr>
<tr>
<td></td>
<td>Alarm Counter</td>
</tr>
<tr>
<td></td>
<td>Alarm verification</td>
</tr>
<tr>
<td></td>
<td>Sounder silence</td>
</tr>
<tr>
<td><strong>Dialing Time</strong></td>
<td>4 second per loop for 127 devices, 3 second per loop for MCPs</td>
</tr>
<tr>
<td><strong>Software</strong></td>
<td>Firmware</td>
</tr>
<tr>
<td></td>
<td>Field configuration programmable</td>
</tr>
<tr>
<td><strong>Memory</strong></td>
<td>EPROM non volatile for 600 event memory storage</td>
</tr>
<tr>
<td><strong>Configuration</strong></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>1 no. 80 column external printer</td>
</tr>
<tr>
<td></td>
<td>1 no. menu driven membrane switch keyboard</td>
</tr>
<tr>
<td></td>
<td>1 set control switches</td>
</tr>
<tr>
<td></td>
<td>1 set operator push buttons</td>
</tr>
<tr>
<td></td>
<td>Loop cards</td>
</tr>
<tr>
<td></td>
<td>Remote terminal unit connection port</td>
</tr>
<tr>
<td></td>
<td>LCD display &amp; driver module</td>
</tr>
<tr>
<td><strong>Connectivity</strong></td>
<td>To proprietary protocol compatible to analogue addressable detectors of type</td>
</tr>
<tr>
<td><strong>LCD display</strong></td>
<td>4 X 160 character alpha numeric LCD auto back-lit with occurrence of event or manual override</td>
</tr>
<tr>
<td><strong>Display Format</strong></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><strong>Power supply</strong></td>
<td>SMPS</td>
</tr>
<tr>
<td><strong>Back up power supply</strong></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>-------------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>Test features</td>
<td></td>
</tr>
<tr>
<td>Panel self test</td>
<td></td>
</tr>
<tr>
<td>LCD test</td>
<td></td>
</tr>
<tr>
<td>Fault test</td>
<td></td>
</tr>
<tr>
<td>Detector test</td>
<td></td>
</tr>
<tr>
<td>Battery fault</td>
<td></td>
</tr>
<tr>
<td>Internal hooter test</td>
<td></td>
</tr>
<tr>
<td>External hooter test</td>
<td></td>
</tr>
<tr>
<td>Control facility</td>
<td></td>
</tr>
<tr>
<td>Scroll/next</td>
<td></td>
</tr>
<tr>
<td>Alarm silence</td>
<td></td>
</tr>
<tr>
<td>Fault silence</td>
<td></td>
</tr>
<tr>
<td>Lamp evacuate</td>
<td></td>
</tr>
<tr>
<td>System reset</td>
<td></td>
</tr>
<tr>
<td>LCD back Lighting</td>
<td></td>
</tr>
<tr>
<td>Trouble Silence</td>
<td></td>
</tr>
<tr>
<td>Indications</td>
<td></td>
</tr>
<tr>
<td>System normal</td>
<td></td>
</tr>
<tr>
<td>Priority 1 Alarm</td>
<td></td>
</tr>
<tr>
<td>Priority 2 Alarm</td>
<td></td>
</tr>
<tr>
<td>Fault</td>
<td></td>
</tr>
<tr>
<td>Alarm Silence</td>
<td></td>
</tr>
<tr>
<td>Power ON</td>
<td></td>
</tr>
<tr>
<td>Battery ON</td>
<td></td>
</tr>
<tr>
<td>Event report</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>Address</td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td></td>
</tr>
<tr>
<td>Time/day/date</td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td></td>
</tr>
<tr>
<td>Zone recording</td>
<td>In order of occurrence regradless of alarm priority</td>
</tr>
<tr>
<td></td>
<td>Print Interrupt of occurrence of fresh event &amp; on its record resume print</td>
</tr>
<tr>
<td>Testing facility</td>
<td>Possible with digital and analogue input and output digital simulation from panel through software</td>
</tr>
<tr>
<td></td>
<td>Under maintenance mode testing possible with balance system in normal operation</td>
</tr>
<tr>
<td>Fire pattern</td>
<td>No alarm issue for short duration</td>
</tr>
<tr>
<td></td>
<td>Quick response for fast smoke build up</td>
</tr>
<tr>
<td></td>
<td>Early detection and suitable modification for of alarm level for dirt accumulation</td>
</tr>
<tr>
<td></td>
<td>Programmed output actuation</td>
</tr>
<tr>
<td></td>
<td>Access protection through 4 levels of pass words</td>
</tr>
<tr>
<td></td>
<td>Hardware security lock</td>
</tr>
<tr>
<td></td>
<td>Detector sensitivity adjustment and display of set value</td>
</tr>
<tr>
<td></td>
<td>Disable/isolate detectors/ interface units</td>
</tr>
<tr>
<td></td>
<td>Single button operation front panels keys</td>
</tr>
<tr>
<td>Software facility</td>
<td>Individual detector</td>
</tr>
<tr>
<td>------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Sensitivity setting</td>
</tr>
<tr>
<td></td>
<td>Trending</td>
</tr>
<tr>
<td></td>
<td>Adjustable dual alarm thresholds</td>
</tr>
<tr>
<td></td>
<td>Pre alert warning</td>
</tr>
<tr>
<td></td>
<td>Cross zoning</td>
</tr>
<tr>
<td></td>
<td>Alarm verifications</td>
</tr>
<tr>
<td></td>
<td>Input/ output assignment</td>
</tr>
<tr>
<td></td>
<td>Event history indexing</td>
</tr>
<tr>
<td>Local Sounder</td>
<td>Yes</td>
</tr>
<tr>
<td>Panel Sounder</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, phosphattizted, putty finished. Double primer and final epoxy painted FIRE RED shade</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>

1.8. 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 640 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>Item</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>
<tr>
<td>LCD display</td>
<td>Back lit, Alphanumeric, 4 line 160 character display</td>
</tr>
<tr>
<td>Data interface</td>
<td>RS 485 serial bus driver board</td>
</tr>
<tr>
<td>Mounting</td>
<td>Suitable for both surface &amp; recess mounting</td>
</tr>
<tr>
<td>Enclosure</td>
<td>1.8 mm sheet steel, dust and vermin proof</td>
</tr>
<tr>
<td></td>
<td>Hinged lockable double door</td>
</tr>
<tr>
<td>Ambient</td>
<td>From(-) 5o C to (+) 450 C Max</td>
</tr>
<tr>
<td>Humidity</td>
<td>15 % to 95 % non condensing</td>
</tr>
<tr>
<td>Paint</td>
<td>Degreased, de - rusted, pickled, rinsed, phosphatized epoxy painted in FIRE RED paint</td>
</tr>
<tr>
<td>Local sounder</td>
<td>Yes</td>
</tr>
</tbody>
</table>

1.9. 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.

1.10. **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.

1.11. **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.

1.12. **SYSTEM COMPONENTS - ADDRESSABLE DEVICES**

1.12.1. **DETECTORS & ADDRESSABLE DEVICES**

The addressable detector and devices shall comply to the below mentioned specifications. The addressing of detectors and devices shall be of rotary type electronic addressing shall not be acceptable.

1. **Intelligent Laser Photo Smoke Detector**

a) The intelligent laser photo smoke detector shall be a spot type detector that incorporates an extremely bright laser diode and an integral lens that focuses the light beam to a very small volume near a receiving photo sensor. The scattering of smoke particles shall activate the photo sensor.
b) The laser detector shall have conductive plastic so that dust accumulation is reduced significantly.

c) The intelligent laser photo detector shall have nine sensitivity levels and be sensitive to a minimum obscuration of 0.03 percent per foot.

d) The laser detector shall not require expensive conduit, special fittings or PVC pipe.

e) The intelligent laser photo detector shall support standard, relay, isolator and sounder detector bases.

f) The laser photo detector shall not require other cleaning requirements than those listed in NFPA 72. Replacement, refurbishment or specialized cleaning of the detector head shall not be required.

g) The laser photo detector shall include two bi-color LEDs that flash green in normal operation and turn on steady red in alarm.

II. Intelligent Multi Criteria Acclimating Detector

a) 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.

b) 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).

c) 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.

III. Intelligent Thermal Detectors

Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.

IV. Intelligent Photoelectric Smoke Detector

The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

V. Intelligent Multi Sensor Intelliquad Detector (CO, IR, Smoke & Heat)

a) The intelligent multi sensor Intelliquad detector shall be an addressable device that is designed to monitor a minimum of photoelectric, thermal technologies, carbon monoxide & infrared in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to
determine it's environment and choose the appropriate sensing settings. The
detector design shall allow a wide sensitivity window, no less than 1 to 4% per
foot obscuration. This detector shall utilize advanced electronics that react to slow
smoldering fires and thermal properties all within a single sensing device.

b) The microprocessor design shall be capable of selecting the appropriate
sensitivity levels based on the environment type it is in (office, manufacturing,
parking etc.) and then have the ability to automatically change the setting as the
environment changes (as walls are moved or as the occupancy changes).

c) The intelligent multi sensor detection device shall include the ability to combine the
all of four signals 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.

VI. Intelligent Duct Smoke Detector

a) The smoke detector housing shall accommodate either an intelligent ionization
detector or an intelligent photoelectric detector, of that provides continuous
analog monitoring and alarm verification from the panel.

b) When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and
appropriate action taken to change over air handling systems to help prevent the
rapid distribution of toxic smoke and fire gases throughout the areas served by
the duct system.

a) Isolator modules shall be provided to automatically isolate wire-to-wire short
circuits on an SLC Class A or Class B branch. The isolator module shall limit the
number of modules or detectors that may be rendered inoperative by a short
circuit fault on the SLC loop segment or branch. At least one isolator module shall
be provided for each floor or protected zone of the building.

b) 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.

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

d) The isolator module shall provide a single LED that shall flash to indicate that the
isolator is operational and shall illuminate steadily to indicate that a short circuit
condition has been detected and isolated.

e) The isolator module shall not consume any detector or device address from the
loop capacity.

VII. Addressable Control Relay Module

Addressable Relay Modules shall be available for HVAC control and other building
functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0
Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection
requirements, and to insure that 100% of all auxiliary relay or NACs may be energized
at the same time on the same pair of wires.
VIII. Addressable Control Module
   a) Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered polarized audio/visual notification appliances.
   b) 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.
   c) Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised UL listed remote power supply.
   d) The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.

IX. Manual Pull Stations
   The fire alarm station shall be of polycarbonate construction and incorporate an internal toggle switch. A locked test feature shall be provided. The station shall be finished in red with silver "PULL IN CASE OF FIRE" lettering.

X. Programmable Electronic Exit Point Directional Sounders With Strobe Light
   b) Electronic sounders shall operate on 24 VDC nominal.
   c) 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.
   d) Shall be capable to broadcast pre programmed Voice Message also
   e) Shall be flush or surface mounted as shown on plans.
   f) Shall produce broad band directional sound with 20 Hz to 20 Khz frequency band to guide occupants to safe exists even in complete darkness.
   g) Strobe lights shall meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria:
   h) The maximum pulse duration shall be 2/10 of one second.
   i) Strobe intensity shall meet the requirements of UL 1971.
   j) The flash rate shall meet the requirements of UL 1971.
   k) Field Wiring Terminal Blocks
   l) For ease of service all panel I/O wiring terminal blocks shall be removable, plug-in types and have sufficient capacity for #18 to #12 AWG wire. Terminal blocks that are permanently fixed are not acceptable.

1.13. 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.

1.14. **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.

1.15. **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 typed written "Sequence of Operation."

2. **PUBLIC ADDRESS SYSTEM CUM VOICE EVACUATION SYSTEM**

2.1. **Introduction**

The Networked Digital Public address system is configured for broadcasting information and emergency announcements to the public. A public address system which will be provided should be IP networked system. The public address system shall also be integrated to Voice evacuation module of Fire Alarm & detection system and suitable for use during all emergency conditions.

2.2. **General Description**

Public Address system provided should be completely networkable over IP. The system will distribute background music and pre-recorded messages through the graphical user interface and live announcements from the call stations. The recessed ceiling-type loudspeakers are to be used mostly providing PA coverage in where the false ceiling is present. For areas without false ceiling, wall mount loudspeakers will be installed to provide PA coverage. The PA system should be installed at the Fire Control Room in OPD Building. The system is supplied with user-friendly software for system configuration. This allows all system functions to be configured. The software is based on web technology, which gives authorized users full freedom of configuration in terms of time and location. The system architecture should be daisy chain in nature complying with the following standards.
BS 5839-8 – Code practice for the design, installation and servicing of voice alarm system.

IEC 60849 – Sound systems for emergency purposes

BS EN 54 -16 -Voice control indicating equipment and alarms

Emergency according to EN60849/EN54-16/ISO 7240-16

EN-54 - For entire Public Address system

The system should allow an undistorted speech reproduction of 85dB SPL at listening level. The system should also provide uniform coverage within +/-5dB for the entire area.

2.3. Call Station Function

Call Station: The operator/user can make an announcement to any zone or any combination of zones of that station via the call station. The type of announcements from the call station are as follows:

- Live announcements
- Pre-recorded announcements
- Background Music

2.4. Pre-recorded emergency announcements / Emergency Announcements:

The pre-recorded announcements can be initiated by the fire alarm signal that is sent from the fire alarm system. The operator can make an announcement to any combination of zones in the system.

a) Pre-recorded Announcements: The pre-recorded announcement can be activated from the pre-defined keys at the call station, and scheduled to be played at specific times.

b) Fault Indication: The failure of the PA equipment will be notified to the call station in the system; and the fault will also be presented at the configuration / diagnostic and logging PC located in the communications equipment room in the building.

The PA system should be capable of integration with BMS system seamlessly. It provides digital audio signal processing and transmission of audio signals via a simple IP network system. The audio transmission in the system is in digital form except for the 100V line from the power amplifiers to the loudspeakers.

The PA system is comprised of the following basic elements:

- Network controller
- Power Amplifiers
- PA call stations
- Network cables
- Loudspeakers
- Background Music Source

The PA system elements are connected by the daisy chain principle. The interconnection between the system units is achieved by using optical fibre cable. The system cabling can be implemented in ring network whereby a single failure on the network cable will not affect the functioning of the system.
The equipment for the PA system, i.e. network controller, power amplifiers, and PA call stations, have built-in audio processing facilities, the audio processing is done in the digital domain.

The distribution of PA cables is configured to ensure that the failure of an amplifier, a cable or a speaker does not render the PA system inoperative or result in the total loss of PA facility in any part of any zone.

### 2.5. Equipment Specification

#### 1. Network controller

The control unit is the heart of the public address system. The unit shall be capable of routing minimum 28 audio channels, delivering power to the system, fault reporting and controlling of the system. This unit can work either as stand-alone mode or with a PC connected to it. It should have at least the following functionalities:

- There shall be 8 control inputs, which should be freely programmable.
- The network controller shall have analog audio line outputs for fire alarm signals, music sources etc.
- The network controller shall have the capability to handle at least 100 levels of priorities and at least 200 zones, 30 call stations or MMI (Man Machine Interface)
- The network controller shall monitor the status of all zones in the system and the last 200 status change and fault events should be logged.
- Attention and alarm tone definitions shall be stored in the network controller or recalled from an external storage device through control ports. These tones can be accessed by any call stations or control inputs for announcement broadcast or alarm broadcast.
- At least 4 pre-recorded messages should be played simultaneously.
- The network control unit shall have extensive audio processing possibilities for audio inputs and audio outputs. Parametric equalization, limiter, and gain can be adjusted with the configuration software.
- The network controller shall monitor the status of all equipment including the status of the microphone capsule of a call station and report any fault.
- The network controller should have hot standby auto switchover facility to redundant controller.
- The system shall be able to make emergency calls (all calls) even if the network controller has failed.
- The controller should 16X2 front panel LCD display and rotary control, through which debugging of faults will be possible.
- The network controller is EN-54 certified and complies with the safety and emergency standards according to EN54-16 and EN60849 standards

<table>
<thead>
<tr>
<th>Power Source</th>
<th>115/230 VAC ±10%, 50/60 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery Power Supply</td>
<td>48V DC</td>
</tr>
<tr>
<td>Power consumption</td>
<td>14W with no load, 150W with maximum load</td>
</tr>
<tr>
<td>Audio inputs</td>
<td>28 channels</td>
</tr>
<tr>
<td>Control Inputs</td>
<td>8</td>
</tr>
<tr>
<td>Control Outputs</td>
<td>8</td>
</tr>
</tbody>
</table>
II. **Power amplifiers**

The main function of the power amplifier is the amplification of audio signals for the loudspeakers. It shall be possible to select the output voltage between 100V and 70V by changing jumpers.

It should have at least the following functionalities:

The amplifier should have DSP built in for Equalization, delay settings etc. The noise dependant Automatic Volume Control (AVC) circuitry should be built in. Each amplifier should have min two channels for AVC function.

The amplifier monitoring and changeover facility shall be incorporated with the power amplifier. The changeover relays shall be integrated with the standby unit. In case of failure of any working amplifier, the standby amplifier shall automatically come in the circuit.

The amplifier should have rotary or push control for selection of system enquiry mode and Headphone volume along with LCD display.

The amplifier should have the built-in line and loudspeaker supervision, automatic volume control, automatic ventilation temperature control, auto change over to DC power supply.

The power amplifier should be capable of monitoring the speaker lines (zones) connected to it through pilot tone supervision.

Separate amplifiers or separate channels of amplifiers for every zone.

The network controller is EN-54 certified and complies with the safety and emergency standards according to EN54-16 and EN60849 standards.

<table>
<thead>
<tr>
<th>Mains supply</th>
<th>115/230VAC +/-10% at 50 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Amplifiers</td>
<td>Class D</td>
</tr>
<tr>
<td>Indication &amp; Controls</td>
<td>854-character LCD display for status display Rotary/push control for selection of system enquiry mode</td>
</tr>
<tr>
<td>Output power</td>
<td>1 x 500W, 2 x 250W, 4 x 125W, 8 x 60W or as required.</td>
</tr>
<tr>
<td>Outputs</td>
<td>Selectable 100V, 70V.</td>
</tr>
<tr>
<td>Audio Inputs</td>
<td>Mono, balanced</td>
</tr>
<tr>
<td>Control Inputs</td>
<td>8</td>
</tr>
<tr>
<td>Control Outputs</td>
<td>1 or 2 or 4 or 8 depending on the amplifier type.</td>
</tr>
<tr>
<td>Frequency response</td>
<td>60 Hz to 20 kHz (-3 dB).</td>
</tr>
<tr>
<td>Frequency Response</td>
<td>Line: -3dB at 20Hz and 20KHz</td>
</tr>
<tr>
<td></td>
<td>Mic: -3dB at 100Hz to 16KHz</td>
</tr>
<tr>
<td>Total harmonic distortion</td>
<td>&lt;0.3% (1 kHz) at 50% of rated power</td>
</tr>
<tr>
<td>Cross talk</td>
<td>-70 dB (1 kHz) nominal (only multichannel).</td>
</tr>
<tr>
<td>Signal to noise ratio</td>
<td>&gt;85 dB with pilot tone off</td>
</tr>
</tbody>
</table>

| Line Outputs | 4 |
| Operating Temperature | -50 degree C to +55 degree C |
| Frequency response | 20 Hz to 20 kHz (-3 dB) |
| Event Logs | 200 |
Battery Power Supply | 48V
--- | ---
Safety and Emergency | According to EN 60849 and EN 54-16

### III. Loudspeaker

<table>
<thead>
<tr>
<th>Rated Power</th>
<th>6W</th>
<th>12W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound pressure level at rated power</td>
<td>90 dB</td>
<td>100 dB</td>
</tr>
<tr>
<td>Frequency Range (-10dB)</td>
<td>80Hz to 20 KHz</td>
<td>55Hz to 20 kHz</td>
</tr>
<tr>
<td>Opening Angle at 1 kHz/4 kHz (-6 dB)</td>
<td>180° / 50°</td>
<td>180° / 64°</td>
</tr>
<tr>
<td>Rated Voltage</td>
<td>100 V / 70</td>
<td>100 V / 70</td>
</tr>
<tr>
<td>Colour</td>
<td>off-white (RAL 9010)</td>
<td>off-white (RAL 9010)</td>
</tr>
<tr>
<td>Safety compliance</td>
<td>EN60065</td>
<td>EN60065</td>
</tr>
</tbody>
</table>

### IV. Metal Grille Ceiling/Wall Speakers

Compact 6W/12W or as required ceiling/wall speakers with fire dome for indoor areas. Speakers should have wide opening angle, with perforated metal grill of approved color and with the following specifications. The speakers are EN-54 certified and complies with the safety and emergency standards according to EN54 and EN60849 standards.

### V. Metal Column Speakers

Compact 20W or as required Column speakers with fire dome for indoor areas. Speakers should have wide opening angle, with perforated metal grill of approved color and with the following specifications. The speakers are EN-54 certified and complies with the safety and emergency standards according to EN54 and EN60849 standards.

<table>
<thead>
<tr>
<th>Rated Power</th>
<th>20 W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound pressure level at rated power</td>
<td>105 dB</td>
</tr>
<tr>
<td>Frequency Range (-10dB)</td>
<td>240Hz to 16 KHz</td>
</tr>
<tr>
<td>Horizontal Opening Angle at 1 kHz/4 kHz (-6 dB)</td>
<td>210° / 82°</td>
</tr>
<tr>
<td>Vertical Opening Angle at 1 kHz/4 kHz (-6 dB)</td>
<td>82° / 24°</td>
</tr>
<tr>
<td>Rated Voltage</td>
<td>100 V</td>
</tr>
<tr>
<td>Colour</td>
<td>off-white (RAL 9010)</td>
</tr>
<tr>
<td>Safety compliance</td>
<td>EN60065</td>
</tr>
</tbody>
</table>

### VI. Call Station

#### a. Remote Call Station

Remote call station basic is used to make manual or pre-recorded announcements to any pre-assigned zones or to executing predefined actions. The call station basic has a microphone on a flexible stem to transmit speech over the network, one push-to talk button and a headset socket. When a headset is connected the microphone and speaker are muted.

The remote call station is powered by the call station interface via the CAT-6a cable (STP), but a local power supply connection is also provided for long distance use with many keypads. The remote call station is fully supervised and complies to IEC60849. Even in case the network controller would fail, the remote call station is still able to do emergency calls (fail safe).

The network controller is EN-54 certified and complies with the safety and emergency standards according to EN54-16 and EN60849 standards.
b. **Call station keypad**

Safety covers to prevent accidental activation of the keys should be available as an option.

The keypad gets its power from the call station where it is connected to. The call station keypad shall have following features:

**Controls and indicators**

- Eight function keys
- Eight two-color LEDs
- Interconnections
- Two serial data and power connections

<table>
<thead>
<tr>
<th>External power supply</th>
<th>20 to 58 V (dc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Frequency response</td>
<td>340 Hz – 14 kHz (-3 dB)</td>
</tr>
<tr>
<td>Nominal input level</td>
<td>75 to 90 dBSPL</td>
</tr>
<tr>
<td>Total harmonic distortion</td>
<td>&lt; 0.5 % (1kHz)</td>
</tr>
<tr>
<td>Signal-to-noise ratio</td>
<td>&gt; 60 dB at 85 dBSPL</td>
</tr>
<tr>
<td>Headset Mic input sensitivity</td>
<td>sensitivity -44 to -59 dBV (configurable)</td>
</tr>
<tr>
<td>Headphones impedance</td>
<td>32 Ohm</td>
</tr>
<tr>
<td>Safety compliance</td>
<td>EN60065</td>
</tr>
</tbody>
</table>

c. **PC Call station**

The PC call stations will be used for the Controller’s call stations in the main Control Room.

The PC Call station is used for making live speech or pre-record announcements to any zone or a group of zones or to execute any pre-defined actions. The PC Call Station is comprised of a high quality microphone on a gooseneck, user-friendly operation PC software and a PC with a 19” Touch screen LCD monitor. The PC Call station software provides the user with a powerful and easy-to-use tool that brings all aspects of announcements to a single point control.

The on-screen configuration sections allow the user to enter the properties of zones of individual zone such as entering the name of a zone/group, pre-defined input/output relay actions and selected attention/alarm tones or pre-recorded messages. After configuration, the user can operate the system via the Operation key layout section.

**Configuration, Diagnostic and Logging Software**

**Configuration Software:** The configuration software is required for every system. Once the configuration has been completed with data entry and downloaded to the network controller, the system can operate without the configuration PC. The configuration software is required only during installation and when changes are made to the existing system configuration. The configuration software is designed to allow even first-time users to navigate easily through the configuration.

**Diagnostic and Logging Software:** The main function of the diagnostic & logging software is to monitor and record the status of all elements of the PA system. This software handles logging of all events like calls and status change of system elements, and gives a current view of the status of the system. This software section can be used for realtime logging by connecting a PC to the network controller, via TCP/IP.

**File Transfer Software:** The main purpose of the file transfer software is to transfer both data and audio files from the PC to the network controller.
d. IP Audio Interface

The VOIP interface is a universal, IP-based audio device supporting VoIP and Audio over IP applications. It is an ideal solution for bridging audio and contact closures over long distance LAN and WAN networks, The unit has analog audio inputs and outputs for easy interfacing with optional pilot-tone supervision for emergency sound purposes. One audio input can be switched to microphone sensitivity with built-in microphone supervision. Also, the control inputs offer cable and connection supervision. Control inputs and outputs can be used to set up an audio connection to start a remote call, but also to pass remote fault events to the system controller.

e. Audio

Multiple audio formats are supported: single channel, full duplex 16-bit PCM or G.711 for very low latency, and two channel send or receive MP3 for high quality audio with various sample rates and compression settings.

f. Audio formats

- MPEG 1-layer 3 (MP3) 32, 44.1 and 48 kHz sample rate
- Encoding up to 192 kbps VBR
- Decoding up to 320 kbps (stereo)
- MPEG 1-layer 2 16, 22.05 and 24 kHz sample rate
- G.711 uLaw, aLaw at 8, 24 or 32 kHz sample rate
- PCM 16-bit at 8, 24 or 32 kHz sample rate

g. Network Interfaces

The unit interfaces to 10 and 100 Mbit Ethernet networks and announces its IP address that was given by a DHCP server. It can also search the network for a free IP address or can be given a static IP-address. A second Ethernet connection is available to support network redundancy. An RS 232 interface is build in to communicate additional serial data over the IP network.

Connector Dual RJ45, DTE-pinout

Standard 802.3i / 802.3u

Speed 10 / 100 Mbps, auto-negotiation

Flow Full / half-duplex, auto-negotiation

Protocol TCP/IP, UDP, RTP, IGMP, DHCP,SNMP
CHAPTER –I

TECHNICAL SPECIFICATIONS – LOW VOLTAGE SYSTEM

1. LAN NETWORKING & WIFI SYSTEM

1.1. General:

RJ 45 data outlets are proposed to be provided for Computers, networking, telephones, WiFi, etc. 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 CAT6a wiring in recessed conduit/Raceways.

The maximum length of the CAT6A 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.

The Server is proposed to be located in server rooms in Hospital Block & Medical College. The main server shall be connected to Distribution switch through Optical fiber cable of 40 Gbps and Distribution switch shall be connected to Edge switches of each building/block with fiber cable of 10 Gbps link in underground HDPE pipe of suitable size in outside connectivity or in cable raceway/conduit inside the buildings. Brick masonry manholes with covers shall be provided at suitable lengths to facilitate easy wire pulling & Maintenance.

Wireless access points for Wi-Fi connectivity are proposed in Hospital Block, medical college, Nursing College, Ayush Hospital, Hostel blocks, Auditorium etc. All types of hostel shall have only Wi-Fi connectivity whereas other buildings in the complex shall be with wired data outlets along with the Wi-Fi connectivity.

20% LAN switches, Wifi routers shall be provided as spare as required & as per directions of EIC.

The LAN SYSTEM comprises of Passive components and Active Components. The Technical specifications of both the components are given below:

1.2. PASSIVE (STRUCTURED CABLEING)

1.2.1. Specification for CAT 6A LSZH U/UTP Cable

<table>
<thead>
<tr>
<th>Standard Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel Performance</td>
</tr>
<tr>
<td>The Category 6A/ Class EA UTP SCS shall comply with the following standards</td>
</tr>
<tr>
<td>a) ISO/IEC 11801:2010</td>
</tr>
<tr>
<td>b) EN 50173 Part 1 through Part 5:2010 and 2011</td>
</tr>
<tr>
<td>c) ANSI/TIA-568-C</td>
</tr>
<tr>
<td>d) IEC 60603-7-4</td>
</tr>
<tr>
<td>e) IEEE 802.3 applications</td>
</tr>
<tr>
<td>The Category 6A/ Class EA UTP system should support the following IEEE Ethernet applications</td>
</tr>
<tr>
<td>a) 802.3e - 1BASE 5</td>
</tr>
<tr>
<td>b) 802.3i - 10BASE-T</td>
</tr>
<tr>
<td>c) 802.3u - 100BASE-TX, 100BASE-T4</td>
</tr>
<tr>
<td>d) 802.3y - 100BASE-T2</td>
</tr>
</tbody>
</table>
**E) 802.3z - 1000BASE-X**

**F) 8023ab - 1000BASE-T**

**G) 802.af - Power Over Ethernet (15.4W)**

**H) 802.3at - Power Over Ethernet Enhancements (25.5W)**

**I) 802.3az - Energy Efficient Ethernet**

Additionally, the Category 6A/Class EA UTP SCS shall be capable of supporting the following Fibre Channel Applications Standards, per Technical Committee 11 of INCITS:

**A) 1GFC-BASE-T**

**B) 2GFC-BASE-T**

**C) 4GFC-BASE-T**

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 6A UTP SCS, when configured as a worst-case 100 metre channel shall provide performance headroom over limits specified by Cat6A NeXT (Near end Cross Talk)- Minimum 3 db above the standards;

Should support a minimum of 4 connector Channel with a minimum 3 db guaranteed NeXT Insertion Loss - 3%

Return Loss - 1.0 db

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 6A Channel requirements if constructed with components from different vendors.

The Category 6A cable and Category 6A channel components shall be manufactured by a single manufacturer.

The SCS must be tested by an ISP 17025 accredited 3rd Party test facility to EIA/TIA 568C, ISO/IEC 11801 Amendment 1 and for the channel testing must be provided as part of the bid response.

The Category 6A system should support channels that are shorter than 15 meters for 2, 3, 4 connector channels without any minimum length requirements.

**Horizontal Cable**

The Cable should meet ANSI/TIA 568C.2 Category 6A Specifications

Cables should have TRACKING Number to check the genuineness/ 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 Cable should be round in shape

The weight of the cable box of 1000 Feet should not be less than 34.7 lb

The nominal Jacket thickness should be 0.05 inches

The nominal Outside diameter should not be more than 0.285 inches

The cable should support the installation temperature: 0 to 60 °C

It should support Operating temperature of -20 to 60 °C

The cable shall be available in Low-Smoke, Zero Halogen (LSZH) compatibility and The LSZH version must comply with the following Fire Safety standards:

1) ISO/IEC 60332-3-22: Vertical Flame Spread
2) ISO/IEC 60754-2: Acidity
3) ISO/IEC 61034-2: Smoke Density

The cable and cordage shall be “True UTP” components that do not include internal or external shields, screened components or drain wires. No Special Grounding requirements.

1.2.2. Specification for Category 6A U/UTP Information Outlets

**Standard Compliance**

- The 8-pin modular (RJ-45) jacks shall comply with IEC 60603-7-4
- The Category 6A outlets shall be backward compatible with Category 6a and 5E cords and cables.
- The Category 6A outlets shall be of a universal design supporting T568 A & B wiring.
- The information outlet shall have a Current Rating of 1.5 A at 20°C
- The information outlet must support 90 degree cable termination. As some mounting hardware does not allow for cable entry directly from the rear, this capability is necessary
- 3rd Party Verification test certificates shall be provided to show compliance to ISO/IEC 11801 Amendment 2 testing for CAT 6A components.

The 8-pin modular (RJ-45) jacks shall comply with IEC 60603-7-4.

The information outlet will have insertion life of 750 cycles minimum.

1.2.3. Specification for CAT 6A LSZH U/UTP RJ45 Patch Cords

**Standard Compliance**

- SCS must support patch cord lengths of 1 meter minimum and equipment cords of 2 meter minimum and The Patch cords shall be available in Stranded and solid core construction
- 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 7.24 mm.
- Plugs shall be designed with an anti-snag latch to facilitate easy removal during move, add and change processes.
- 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.

1.2.4. Specification for CAT 6A Jack Panel

**Standard Compliance**

**24 or 48 Port Patch Panel**

- The ganged adapter style patch panel will utilise increments of six RJ-45 style jacks in a common moulded component.
- The ganged adapters shall have RJ45 jack in the front and Insulation Displacement Connector (IDC) at the rear of the module.
- 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.
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.

3rd Party Verification test certificates shall be provided to show compliance to ISO/IEC 11801 Amendment 2 testing for Cat 6A components.

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

The patch panel type shall be a 1U (24 port) or 2U (48 port) panel capable of supporting 24 or 48 unshielded modular 8-pin connectors compliant with IEC 60603-7-4 while meeting the Channel Performance as specified in Amendment 1 to ISO/IEC 11801:2002

The panel shall be available in 24-port and 48-port configurations with universal A/B labelling and 110 connector terminations on rear of panel allowing for quick and easy installation of 22 to 24 AWG cable.

The panel shall be equipped with a removable rear mounted cable management bar and front and rear labels.

The panel shall be UL and cUL Listed.

Operating Temperature Range = 14°F to 140°F (-10°C to 60°C)

Storage Temperature Range = -40°F to 158°F (-40°C to 70°C)

Humidity = 95% (non condensing)

Nominal Solid Conductor Diameter = 0.025 to 0.020 in (0.64 to 0.51 mm) (22 to 24 AWG)

Nominal Stranded Conductor Diameter = 0.025 to 0.020 in (0.64 to 0.51 mm) (22 to 24 AWG)

Insulation Types = All plastic insulates (including PVC, Irradiated PVC, Polyethylene, Polypropylene, PTF Polyurethane, Nylon, and FEP)

Insertion Life = 750 minimum insertions of an FCC 8-Position Telecommunications Plug

### 1.2.5. 2 & 4 Port Shuttered Face Plate

**Standard Compliance**

Shall be available in 2 port and 4 port square versions.

**General Specifications**

a) Color: White

b) Width: 86.36 mm (3.4 in)

c) Height: 86.36 mm (3.4 in)

d) Depth: 13.72 mm (0.54 in)

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.

### 1.2.6. 144 CORES - OUTSIDE PLANT FIBER CABLE

**Standard Compliance**

Shall be Single mode (OS2), Double Jacket, Single Armour, 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

### No. of Fibers
- 144

### No. of Tubes
- 12

### Construction Materials
- a) Inner & Outer Jacket Material: MDPE
- b) Armour Type: Corrugated Steel
- c) Number of fibers per tube: 12
- d) Jacket Color: Black
- e) Jacket UV Resistance: UV Stabilized
- f) Subunit Type: Gel-free
- g) No. of Rip cords: 2
- h) Water Swellable Tape: Yes

### Dimensions
- a) Cable Diameter: 20.6 mm (0.81 in)
- b) Cable Weight: 351 kg/km

### Physical Specifications
- a) Minimum Bend Radius, loaded: 30.8 cm
- b) Minimum Bend Radius, unloaded: 20.6 cm
- c) Tensile Load, long term, Max: 800 N
- d) Tensile Load, short term, Max: 2700 N

### Environmental Specifications
- a) Environmental Space: Aerial, lashed or Buried
- b) Installation Temperature: -30 degree Celsius to +70 degree Celsius
- c) Operating Temperature: -40 degree Celsius to +70 degree Celsius
- d) Storage Temperature: -40 degree Celsius to +75 degree Celsius

### Mechanical Test Specifications
- a) Compression: 44 N/mm (as per IEC 60794-1 E3)
- b) Flex: 35 Cycles (as per IEC 60794-1 E6)
- c) Impact: 6.62 N-m (as per IEC 60794-1 E4)
- d) Water Penetration Test Method: 24 h (as per IEC 60794-1 F5)

### Optical Specifications
- **Attenuation, Maximum**
  - a) 0.22 dB/km @ 1550 nm
  - b) 0.27 dB/km @ 1490 nm
  - c) 0.31 dB/km @ 1385 nm
  - d) 0.34 dB/km @ 1310 nm
- **Index of Refraction**
  - a) 1.467 @ 1310 nm
  - b) 1.468 @ 1385 nm
  - c) 1.468 @ 1550 nm
- **Cabled Cut off Wavelength, maximum**: 1260 nm

### 1.2.7. 6/12 CORES INDOOR MM OM3 FIBER CABLE

### Standard Compliance
Shall be Multimode (OM3), Low Smoke Zero Halogen Riser Distribution Cable, 6/12fiber single-unit.

### Qualification Standards
- ANSI/ICEA S-83-596
- Telcordia GR-409

### Standards Compliance
- TIA-492AAAC (OM3), Bend-Insensitive Multimode Fiber

### Flame Test Method
- IEC 60332-3, IEC 60754-2, IEC 61034-2, IEEE 383, UL 1666 and UL 1685

### Regulatory Compliance
- RoHS 2011/65/EU compliant

### Construction Materials

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Jacket Material</td>
<td>LSZH</td>
</tr>
<tr>
<td>b) Jacket Color</td>
<td>Aqua</td>
</tr>
<tr>
<td>c) Subunit Type</td>
<td>Gel-free</td>
</tr>
<tr>
<td>d) Non Armored</td>
<td>Yes</td>
</tr>
<tr>
<td>e) Core/Cladding/ buffer diameter</td>
<td>50 / 125 / 900 µm</td>
</tr>
</tbody>
</table>

### Dimensions

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Cable Diameter</td>
<td>6.07 mm (0.24 in)</td>
</tr>
<tr>
<td>b) Cable Weight</td>
<td>34 kg/km</td>
</tr>
</tbody>
</table>

### Physical Specifications

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Minimum Bend Radius, loaded</td>
<td>9.1 cm</td>
</tr>
<tr>
<td>b) Minimum Bend Radius, unloaded</td>
<td>6.1 cm</td>
</tr>
<tr>
<td>c) Tensile Load, long term, Max</td>
<td>200 N</td>
</tr>
<tr>
<td>d) Tensile Load, short term, Max</td>
<td>667 N</td>
</tr>
<tr>
<td>e) Vertical Rise, Max</td>
<td>500 m</td>
</tr>
</tbody>
</table>

### Environmental Specifications

- Environmental Space: Low Smoke Zero Halogen (LSZH) and Riser
- Installation Temperature: -30 degree Celsius to +60 degree Celsius
- Operating Temperature: -40 degree Celsius to +70 degree Celsius
- Storage Temperature: -40 degree Celsius to +70 degree Celsius

### Mechanical Test Specifications

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Compression</td>
<td>10 N/mm (as per IEC 60794-1 E3)</td>
</tr>
<tr>
<td>b) Flex</td>
<td>100 Cycles (as per IEC 60794-1 E6)</td>
</tr>
<tr>
<td>c) Impact</td>
<td>5.88 N-m (as per IEC 60794-1 E4)</td>
</tr>
</tbody>
</table>

### Optical Specifications

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Attenuation, Maximum</td>
<td>1.00 dB/km @ 1300 nm</td>
</tr>
<tr>
<td>b) Attenuation, Maximum</td>
<td>3.00 dB/km @ 850 nm</td>
</tr>
<tr>
<td>a) Index of Refraction</td>
<td>1.479 @ 1300 nm</td>
</tr>
<tr>
<td>b) Index of Refraction</td>
<td>1.483 @ 850 nm</td>
</tr>
</tbody>
</table>

### 1 Gbps Ethernet Distance

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) 600 m @ 1300 nm</td>
<td></td>
</tr>
<tr>
<td>b) 1020 m @ 850 nm</td>
<td></td>
</tr>
</tbody>
</table>

### 10 Gbps Ethernet Distance

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a) 300 m @ 850 nm</td>
<td></td>
</tr>
</tbody>
</table>

Bandwidth, Laser, Min.
1.2.8. 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

**Minimum Specifications**
- Each pigtai shall have attenuation less than 0.3 dB
- Each Pigtail shall be made of LSZH material
- Each pigtai shall have a return loss of 30 dB or better
- Each pigtai shall be RoHS compliant

1.2.9. Fibre Optic LC style OM3 pigtail for Cassettes

**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

1.2.10. Fiber Optic Patch Cable (LC-LC, SC-LC), 3/5/10 Mtrs. Long, ISO/IEC-11801-OM3 50μ Duplex, LSZH

**Standard Compliance**

**Minimum Specifications**
- 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
- No. of Fibers: 12
- No. of Tubes: 1
- Construction Materials
  - a) Jacket Material: MDPE
### Construction of AIIMS, Guwahati (Assam)

**Vol-VI: Tech Specs**

**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

- **A) Minimum Bend Radius, loaded:** 17.3 cm  
- **B) Minimum Bend Radius, unloaded:** 11.5 cm  
- **C) Tensile Load, long term, Max:** 800 N  
- **D) Tensile Load, short term, Max:** 2700 N

### Environmental Specifications

- **A) Environmental Space:** Aerial, lashed or Buried  
- **B) Installation Temperature:** -30 degree Celsius to +70 degree Celsius  
- **C) Operating Temperature:** -40 degree Celsius to +70 degree Celsius  
- **D) Storage Temperature:** -40 degree Celsius to +75 degree Celsius

### Mechanical Test Specifications

- **A) Compression:** 44 N/mm (as per IEC 60794-1 E3)  
- **B) Flex:** 35 Cycles (as per IEC 60794-1 E6)  
- **C) Impact:** 2.94 N-m (as per IEC 60794-1 E4)  
- **D) Water Penetration Test Method:** 24 h (as per IEC 60794-1 F5)

### Optical Specifications

**Attenuation, Maximum**

- **A) 0.22 dB/km @ 1550 nm**  
- **B) 0.27 dB/km @ 1490 nm**  
- **C) 0.31 dB/km @ 1385 nm**  
- **D) 0.34 dB/km @ 1310 nm**

**Index of Refraction**

- **A) 1.467 @ 1310 nm**  
- **B) 1.468 @ 1385 nm**  
- **C) 1.468 @ 1550 nm**

**Cabled Cutoff Wavelength, maximum:** 1260 nm

### 1.2.12. 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.

### 1.2.13. 12 Fiber Single mode Fiber Pigtail Cassettes

<table>
<thead>
<tr>
<th><strong>Standard Compliance</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Shall be Single mode OS2, zero water peak fiber.</td>
</tr>
<tr>
<td>Regulatory Compliance: RoHS 2011/65/EU</td>
</tr>
<tr>
<td>Safety Standard: UL</td>
</tr>
<tr>
<td>Number of Fiber: 12</td>
</tr>
<tr>
<td>Interface, Front: LC</td>
</tr>
<tr>
<td>Adapter Color: Blue</td>
</tr>
</tbody>
</table>

**Optical Performance**

- Insertion Loss Change, mating: 0.30 dB
- Insertion Loss Change, temperature: 0.30 dB
- Insertion Loss, Typical: 0.30 dB
- Return Loss, Min: 55.0 dB

**Pigtail Environmental Specifications**

- Environmental Space: Plenum
- Operating Temperature: -10 degree Celsius to +60 degree Celsius
- Cable Retention Strength, Max: 1.00 lb @ 0 degree, 1.00 lb @ 90 degree
- Ferrule Geometry: Pre-radiused
- Ferrule Material: Zirconia

**Optical Components Standard:** ANSI/TIA-568-C.3

### 1.2.14. LC – LC Single mode LSZH Patch Cords

<table>
<thead>
<tr>
<th><strong>Standard Compliance</strong></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**

- Connector Color: Blue
- Connector Interface: LC
- Operating Temperature: -10 degree Celsius to +60 degree Celsius

**Connector Optical Performance**

- Insertion Loss, Typical: 0.20 dB
- Return Loss, minimum: 55.0 dB
- Insertion Loss Change, mating: 0.30 dB
- Insertion Loss Change, temperature: 0.30 dB

### 1.2.15. 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 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.

---

1.2.16. **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.

---

1.2.17. **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 Part5: 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
#### 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.

The 20 year warranty shall be a transferable warranty and has component replacement policy in case of manufacturing defect.

- **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**
- **It 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 60754-2Acidity**
- **ISO/IEC 61034-2 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 public website, such that it can be accessed at any time.

### 1.2.18. 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 telecommunications 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

### 1.2.19. Specification for CAT 6A 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-snag 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.

1.2.20. Specification for CAT 6 Jack Panel

<table>
<thead>
<tr>
<th>Standard Compliance</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>

1.2.21. 42/15/12 U Closed Rack (2 Type of 42 U 800X800 & 800X1000 & 600X600 15/12 U)

<table>
<thead>
<tr>
<th>Standard Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Post 19&quot; 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>
1.2.22. **Testing & Commissioning of Passive Components:**

All the passive components shall have their Testing reports from the OEM with Batch No. and all standard parameters for AIIMS Guwahati complex. There shall be the proper ferruling and Numbering on the CAT 6A/fiber cables. There Shall be proper dressing of the cables and equipment management inside the racks.

The Cat 6A cable installation 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.

### 1.3. **ACTIVE COMPONENTS**

#### 1.3.1. Firewall with Unified Threat Management (UTM)

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Description</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>It Should support 1:1 high availability.</td>
</tr>
<tr>
<td>3</td>
<td>It Should have minimum 6 x 10G supporting SFP+ interfaces &amp; 4 x 100/1000/10 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>
<tr>
<td>12</td>
<td>The proposed system should have modules/Licenses for integrated Web Content Filtering along with IPS, Application Control, Antivirus / Malware Protection &amp; Anti spam.</td>
</tr>
<tr>
<td>13</td>
<td>Proposed solution should be an Appliance/Virtual Machine based solution. In case of Virtual Machine based, required server must be quoted by bidder.</td>
</tr>
<tr>
<td>14</td>
<td>It Should have direct OEM TAC support.</td>
</tr>
</tbody>
</table>
### 1.3.2. Core Switch-

<table>
<thead>
<tr>
<th>S. No.</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 8 interface slots and 2 supervisor slots.</td>
</tr>
<tr>
<td>2</td>
<td>Switch should have 24 X 1/10G SFP+ Ports, 24 x 1G/10G Base-T RJ45 and 16 x 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>3</td>
<td>Switch should have minimum 1.2 TB per interface slot throughput &amp; 950 Mpps forwarding rate on Day 1. Switch should be scalable to support additional 192 x 10G Ports or 128 x 40G Ports or 48 x100G Ports at line rate performance.</td>
</tr>
<tr>
<td>4</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>5</td>
<td>It 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>6</td>
<td>Chassis should support 100G interface line-cards for future connectivity requirement without any replacement in hardware configuration.</td>
</tr>
<tr>
<td>7</td>
<td>Switch should have IPv4 &amp; IPv6 static routes, OSPF, OSPFv3, PBR, PIM-SM / DM, BGP, VRF and SDN.</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 prioritizations through QoS.</td>
</tr>
<tr>
<td>10</td>
<td>Switch should support minimum 2K ACL’s, minimum 2K/4K Multicast and 200K Unicast Routes for IPv4 and IPv6.</td>
</tr>
<tr>
<td>11</td>
<td>Should be supplied with hot swappable redundant internal Power Supply.</td>
</tr>
<tr>
<td>12</td>
<td>Should have NetFlow/sflow functionality for traffic monitoring.</td>
</tr>
<tr>
<td>13</td>
<td>The proposed switch should be IPv6 logo certified.</td>
</tr>
<tr>
<td>14</td>
<td>Should have compatibility to work in atmospheric tempemperature range -5 degree C to 50 degree C.</td>
</tr>
</tbody>
</table>

### 1.3.3. Distribution Switch

<table>
<thead>
<tr>
<th>S. No.</th>
<th>TECHNICAL SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Switch should support 40 Gbps of stacking bandwidth</td>
</tr>
<tr>
<td>2</td>
<td>Should have compatibility to work in atmospheric tempemperature range -5 degree C to 50 degree C.</td>
</tr>
<tr>
<td>3</td>
<td>Switch ports should be populated with 24 x 1G loaded with 12 x 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>4</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>5</td>
<td>Should be supplied with hot swappable redundant internal Power Supply.</td>
</tr>
<tr>
<td>6</td>
<td>Switch should have dedicated 1 x 10/100/1000 Base T port for Out of band Management port.</td>
</tr>
<tr>
<td>7</td>
<td>Switch should have IPv4 &amp; IPv6 static routes and support for OSPF</td>
</tr>
</tbody>
</table>
8. Should support Layer 2 protocols 802.1d, 802.1s, 802.1w and 802.3ad & RFC 3619/G.8032 for sub 50ms failover.

9. Switch should support minimum 8 hardware queues per port for applying various traffic prioritization through QoS.

10. Switch should support SP Queuing, minimum 1K ACL's, 2K/4K Multicast and WRED/WTD. Network OS, 400 Unicast Routes, IPv4 and IPv6 compliant.


12. Should be upgradable to support Open Flow or equivalent functionality, to support SDN (Software Defined Networking).

13. Switch should support port security, DHCP snooping, Dynamic ARP inspection, IP Source guard, BPDU Guard, Spanning tree root guard. IPv6 RA guard Should have MAC security – Lockdown & Limit and MAC address tracking with syslog & SNMP notification, Multicast traceroute.


15. The proposed switch should be IPv6 logo certified. Desirable: EAL2 / NDPP / NDcPP certification.

16. Should have direct OEM 24x7x365 TAC support and Advanced hardware replacement warranty.

### 1.3.4. 48 Port PoE+ Layer 2 Switch

<table>
<thead>
<tr>
<th>S. No.</th>
<th>TECHNICAL SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Should have minimum 48 X 10/100/1000 BaseT PoE/PoE+ RJ45 Ports (minimum 740W) plus 2 x 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 40 Gbps of stacking bandwidth proposed with stacking cable. Stacking should support up to 8 Stacking members.</td>
</tr>
<tr>
<td>3</td>
<td>Should have compatibility to work in atmospheric temperature range -5 degree C to 50 degree C.</td>
</tr>
<tr>
<td>4</td>
<td>Switch should support External/Internal Redundant Power Supply</td>
</tr>
<tr>
<td>5</td>
<td>Switch should have dedicated 1 x 10/100/1000 Base T port for Out of band Management port.</td>
</tr>
<tr>
<td>6</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>7</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 &amp; RFC 3619/G.8032 for sub 50ms failover.</td>
</tr>
<tr>
<td>8</td>
<td>Switch should have IPv4 &amp; IPv6 static routes from day 1.</td>
</tr>
<tr>
<td>9</td>
<td>Switch should have minimum 1K ACL's and 500 IPv4 and IPv6 multicast groups.</td>
</tr>
<tr>
<td>10</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>11</td>
<td>Should support 802.1X authentication, Port Security and RADIUS / TACACS integration. Should have MAC security – Lockdown &amp; Limit and MAC address tracking with syslog &amp; SNMP notification, Multicast traceroute.</td>
</tr>
<tr>
<td>12</td>
<td>Should be upgradable to support Open Flow or equivalent functionality, to support SDN (Software Defined Networking).</td>
</tr>
<tr>
<td>13</td>
<td>Should have NetFlow / sFlow/equivalent functionality for traffic monitoring.</td>
</tr>
</tbody>
</table>
Switch should support port security, DHCP snooping, Dynamic ARP inspection, IP Source guard, BPDU Guard, Spanning tree root guard and IPv6 First Hop Security.

The proposed switch should be IPv6 logo certified. Should have EAL2/NDPP/NDcPP certification from Day 1.

Should have direct OEM 24x7x365 TAC support with software update and NBD Advanced hardware replacement warranty.

### 1.3.5. 48 Port Layer 2 Switch

<table>
<thead>
<tr>
<th>S. N.</th>
<th>TECHNICAL SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Should have minimum 48 X 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>2</td>
<td>Should have dedicated 40 Gbps of stacking bandwidth proposed with stacking cable. Stacking should support upto 8 Stacking members. Switch should have dedicated 1 x 10/100/1000 BaseT port for Out of band Management port.</td>
</tr>
<tr>
<td>3</td>
<td>Should have compatibility to work in atmospheric temperature range -5 degree C to 50 degree C.</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 &amp; RFC 3619/G.8032 for sub 50ms failover.</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 500 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 prioritizations through QoS. Switch should support SP Queueing and WRED/WTD</td>
</tr>
<tr>
<td>10</td>
<td>Should support 802.1x authentication, Port Security and RADIUS / TACACS integration. Should have MAC security – Lockdown &amp; Limit and MAC address tracking with syslog &amp; snmp notification, Multicast traceroute.</td>
</tr>
<tr>
<td>11</td>
<td>Should be upgradable to support Open Flow or equivalent functionality, to support SDN (Software Defined Networking).</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.</td>
</tr>
</tbody>
</table>

### 1.3.6. 24 Port PoE+ Layer 2 Access Switch

<table>
<thead>
<tr>
<th>S. N.</th>
<th>TECHNICAL SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Should have minimum 24 X 10/100/1000 BaseT PoE/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 40 Gbps of stacking bandwidth proposed with stacking cable. Stacking should support upto 8 Stacking members. Switch should have dedicated 1 x 10/100/1000 BaseT port for Out of band Management port.</td>
</tr>
</tbody>
</table>
3. Should have compatibility to work in atmospheric temperature range -5 degree C to 50 degree C.

4. Switch should support External/Internal Redundant Power Supply

5. The proposed interfaces must have non-blocking and wire-speed performance for all packet sizes for IPv4 & IPv6 traffic and should have distributed forwarding architecture.

6. 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 & RFC 3619/G.8032 for sub 50ms failover

7. Switch should have IPv4 & IPv6 static routes from day 1

8. Switch should have minimum 1K ACL’s and 500 IPv4 and IPv6 multicast groups.

9. Switch should support minimum 8 hardware queues per port for applying various traffic prioritization through QoS. Switch should support SP Queuing and WRED/WTD.

10. Should support 802.1x authentication, Port Security and RADIUS / TACACS integration. Should have MAC security – Lockdown & Limit and MAC address tracking with syslog & snmp notification, Multicast traceroute.

11. Should be upgradable to support OpenFlow or equivalent functionality, to support SDN (Software Defined Networking).

12. Should have NetFlow / sFlow/ Equivalent functionality for traffic monitoring.


14. The proposed switch should be IPv6 logo certified. Should have EAL2/ NDPP/NDcPP certification from Day 1.

15. Should have direct OEM 24x7x365 TAC support with software update and NBD Advanced hardware replacement warranty.

1.3.7. Authentication, Authorization and Accounting (AAA)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>TECHNICAL SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Proposed AAA solution should be an Appliance based solution.</td>
</tr>
<tr>
<td>2</td>
<td>Proposed solution must support integration and security for both wired and wireless infrastructure. It should be ready to handle 7000 concurrent Devices from day1 and scalable for up to 12000 end systems. Devices are mixture of guest users, institute staff, machine endpoints.</td>
</tr>
<tr>
<td>3</td>
<td>AAA should support BYOD with Self-service authorization and device provisioning via open network.</td>
</tr>
<tr>
<td>4</td>
<td>It must allow for Machine Authentication (or an appropriate alternative) by AD-joined Windows laptops/tablets allowing wireless connection before user login.</td>
</tr>
<tr>
<td>5</td>
<td>The Solution should have detailed reporting capabilities for historical &amp; real time data. Should be equipped with custom report designer to meet the need of specific data attributes and periodic email of the same to relevant administrative team.</td>
</tr>
<tr>
<td>6</td>
<td>The proposed solution should have Built-in user database with per device/user credential management and should also provide Seamless backend integration with RADIUS, AD, LDAP.</td>
</tr>
<tr>
<td>7</td>
<td>Solution should support agentless and agent-based assessment to reduce security vulnerabilities with End system Posture assessment.</td>
</tr>
<tr>
<td>8</td>
<td>Proposed solution should address (but not limited to) the below requirements: Intuitive user/device management and Unified device visibility and reporting Self-service 802.1X and guest access. Should also have option for MAC authentication for selective devices and Social Login.</td>
</tr>
</tbody>
</table>
Integrated AAA server with key policy definitions. Should also support integration with external AAA server.

9. AAA should be able to integrate with existing user databases like Microsoft AD/LDAP/local.

10. It should be scalable to enforce device-specific settings for antivirus, firewall and OS patches, passcodes, NAC, proxies.

11. It should be able to enforce custom user and device privileges.

12. It should have direct OEM 24x7 TAC support with software upgrade and NBD Advanced hardware replacement warranty.

1.3.8. Network Management System (NMS)

<table>
<thead>
<tr>
<th>S. N.</th>
<th>TECHNICAL SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NMS shall be able to monitor and configure 500 devices (should be proposed against the proposed devices) and should have scalability to manage up to 2000 devices in future. NMS shall be able to manage both wired (routing/switching) and wireless networks in single pane of glass management.</td>
</tr>
<tr>
<td>2</td>
<td>NMS should be scalable to provide Deep application visibility using AVC, NetFlow/Sflow, NBAR or packet inspection to recognize a wide variety of applications and SNMP. NMS should be able to provide network topology.</td>
</tr>
<tr>
<td>3</td>
<td>NMS solution should deliver pinpoint visibility into who, what, when, where, and how of wireless access through its own data collection and key integrations. It should support spatial/floor mapping; integrated location-based tracking of client</td>
</tr>
<tr>
<td>4</td>
<td>Should provide a customizable at-a-glance summary of all discovered devices and existing network switches to proactively identify problem areas and help prevent network downtime. The network has to be manageable at Network Operations Center (NOC) and through secured browser.</td>
</tr>
<tr>
<td>5</td>
<td>Should be able to discover, configure, monitor, manage, and deploy configurations to dynamically update groups of devices.</td>
</tr>
<tr>
<td>6</td>
<td>Should allow flexible definitions of administrator roles and responsibilities with RBAC (Role based Access Control) for different teams.</td>
</tr>
<tr>
<td>7</td>
<td>Should enable performance management by providing customizable dashboards and historical data visibility.</td>
</tr>
<tr>
<td>8</td>
<td>Should be able to generate reports designed to summarize utilization of and traffic patterns on network interfaces.</td>
</tr>
<tr>
<td>9</td>
<td>Should allow administrators to track device configuration changes, enabling viewing, retrieval, and restoration of configuration files, and monitoring of configuration drift for troubleshooting purposes.</td>
</tr>
<tr>
<td>10</td>
<td>The system design should provide access to only authorized users, RBAC and by using Secure Digital Certificates to completely trace back an individual user, in case of Cyber Crime or any other cyber investigation, as per the Computer Assets and Information Technology (CAIT) Policy of AIIMS.</td>
</tr>
</tbody>
</table>

1.3.9. Wireless LAN Controller

<table>
<thead>
<tr>
<th>S. N.</th>
<th>TECHNICAL SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Must be compliant with IEEE CAPWAP for controller-based WLANs or equivalent feature</td>
</tr>
<tr>
<td></td>
<td>Requirements</td>
</tr>
<tr>
<td>---</td>
<td>-------------</td>
</tr>
<tr>
<td>2</td>
<td>WLC should support IPv4 and IPv6 including IEEE 802.11a, 802.11b, 802.11g, 802.11d, WMM/802.11e, 802.11n, 802.11ac standards.</td>
</tr>
<tr>
<td>3</td>
<td>WLAN Controller should have minimum 6x of 10/100/1000 Ethernet Ports, 2x USB port and one Console port.</td>
</tr>
<tr>
<td>4</td>
<td>WLC should support up to 500 Access points day 1 and up to 16,000 Devices in a single chassis. Standalone controller should support seamless roaming access over L2/L3 network. Should be a dedicated hardware based appliance with minimum 4 GB RAM and 32 GB storage space. Spinning Hard Drive must be avoided.</td>
</tr>
<tr>
<td>5</td>
<td>There should be 100% redundancy for Primary controller i.e. N: N including Hardware and desired licenses to support AP’s</td>
</tr>
<tr>
<td>6</td>
<td>WLC should provide air-time fairness between these different speed clients – slower clients should not be starved by the faster clients and faster clients should not adversely affected by slower clients.</td>
</tr>
<tr>
<td>7</td>
<td>WLC Must support an ability to dynamically adjust channel, power settings and airtime, based on the RF environment.</td>
</tr>
<tr>
<td>8</td>
<td>WLC should support L2/L3 discovery for AP’s.</td>
</tr>
<tr>
<td>9</td>
<td>Should support adhere to the strictest level of security standards, including 802.11i Wi-Fi Protected Access 2 (WPA2), WPA, 802.1X with multiple Extensible Authentication Protocol (EAP) and 802.1x Authentication.</td>
</tr>
<tr>
<td>10</td>
<td>Controller should support WIDS/WIPS includes rogue AP detection, classification and automatic containment feature and prevention for DOS attacks.</td>
</tr>
<tr>
<td>11</td>
<td>WLC should support L2/L3/L4 Access Control and L2 Client Isolation so User cannot access each other’s devices. Isolation should have option to apply on AP or SSID’s</td>
</tr>
<tr>
<td>12</td>
<td>Controller/System should support Access Control based on Identity/Role/ Device/Time or Application.</td>
</tr>
<tr>
<td>13</td>
<td>Must support client roaming in L2/L3 networks and also across controllers.</td>
</tr>
<tr>
<td>14</td>
<td>Controller should support integrated or External AAA servers including Microsoft AD and Linux based open source AAA.</td>
</tr>
<tr>
<td>15</td>
<td>The Controller/System should support L7 Application/OS/Device finger printing and device type based policies i.e allow or deny, Bandwidth rate limit, VLAN mapping</td>
</tr>
<tr>
<td>16</td>
<td>Wireless Network should support deep packet inspection for all user traffic across Layer 4-7 network to analyses information about applications usage</td>
</tr>
<tr>
<td>17</td>
<td>The controller/System should be able to raise critical alarms by sending an email and/ or SMS.</td>
</tr>
<tr>
<td>18</td>
<td>Per SSID or dynamic Per user bandwidth Rate Limiting</td>
</tr>
<tr>
<td>19</td>
<td>Support advanced multicast features and WMM support to provide best performance on Video applications and should have</td>
</tr>
<tr>
<td>20</td>
<td>Controller/System should have BYOD features and should support integrated/ and external captive portal integration.</td>
</tr>
<tr>
<td>21</td>
<td>System should provide a web-based application that allows non-technical staff to create Guest accounts with validity for fixed duration like hours or days and restricted to number of devices. Password to guest should be shared over Email and SMS (SMS gateway services shall be provided by Campus).</td>
</tr>
<tr>
<td>22</td>
<td>Proposed solution should be an Appliance based solution.</td>
</tr>
<tr>
<td>23</td>
<td>Should have direct OEM 24x7 TAC support with Software upgrade and NBD Advanced hardware replacement warranty.</td>
</tr>
</tbody>
</table>
### 1.3.10. Wireless Indoor Access Points

<table>
<thead>
<tr>
<th>S. N.</th>
<th>TECHNICAL SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wall/Ceiling mounted Wi-Fi access-point suitable for indoor use with at least 2 10/100/1000Mbps Ethernet ports supporting standard 802.3af/at POE+</td>
</tr>
<tr>
<td>2</td>
<td>802.11ac AP should operate in 2.4 GHz (450 Mbps or more) and 5 GHz simultaneously and capable of minimum 1.7Gbps on 5 Ghz for 802.11ac clients supporting minimum4x4 MIMO with 4 spatial streams. It must support minimum 3 concurrent MU-MIMO users.</td>
</tr>
<tr>
<td>3</td>
<td>Should support minimum 16x BSSID per AP. Should have compatibility to work in atmospheric temperature range -5 degree C to 50 degree C.</td>
</tr>
<tr>
<td>4</td>
<td>Must have an dynamic or smart RF Management features which allows WLAN to automatically and intelligently adapt to changes in the RF environment. The access point should support captive portal and local data base for authentication.</td>
</tr>
<tr>
<td>5</td>
<td>Maximum conducted transmit power shall be 24.7 dBm on both 2.4 and 5 GHz with two antennas and EIRP complying to regulatory requirements. The External antenna gain proposed should be minimum 8 dBi or above on both the bands. Should support 20,40 and 80 MHz Channels.</td>
</tr>
<tr>
<td>6</td>
<td>AP should support band steering and load balance across bands and AP’s. The access point or the controller should be capable of running a local DHCP Server.</td>
</tr>
<tr>
<td>7</td>
<td>Security mechanisms should be in place to protect the communication between the Access Point controller and the Access Points. Access points must support a “controllerless” mode where one AP will provide full RF and network management.</td>
</tr>
<tr>
<td>8</td>
<td>The access point should support WPA2 enterprise authentication and AES/CCMP encryption. WLAN solution must support personal and enterprise WPA2 authentication for a staff WLAN concurrent with open access public WLAN.</td>
</tr>
<tr>
<td>9</td>
<td>AP should support 802.11k for Radios Resource management and 802.11r for fast roaming.</td>
</tr>
<tr>
<td>10</td>
<td>Implement Wi-Fi alliance standards WMM, 802.11d, 802.11h and 802.11e and should support VoWLAN</td>
</tr>
<tr>
<td>11</td>
<td>AP must support L7 Application Identification and spectrum analysis functions</td>
</tr>
<tr>
<td>12</td>
<td>AP should support Minimum -90dB Receiving sensitivity. AP should support Receiver sensitivity Threshold to reduce noise reception in the AP to increase SNR and performance</td>
</tr>
<tr>
<td>13</td>
<td>802.11 a/b/g/n/ac wave 2 functionality certified, Wi-Fi alliance Should be approved &amp; certified UL / cUL 60950-1, IEC / EN60950-1, UL2043, RoHS. FCC (USA), EU, TELE, Medical EMC standard: EN/IEC 60601-1-2.</td>
</tr>
<tr>
<td>14</td>
<td>Should have direct OEM 24x7x365 TAC support with software update and NBD advanced hardware replacement warranty.</td>
</tr>
</tbody>
</table>

### 1.3.11. Wireless Outdoor Access Points

<table>
<thead>
<tr>
<th>S. N.</th>
<th>TECHNICAL SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wall/Ceiling/Poll mounted Wi-fi access-point suitable for outdoor use with at least 1 10/100/1000Mbps Ethernet ports supporting standard 802.3af/at POE+</td>
</tr>
<tr>
<td>2</td>
<td>802.11ac AP should operate in 2.4 GHz (450 Mbps or more) and 5 GHz simultaneously and capable of minimum 1.3 Gbps on 5 Ghz for 802.11ac clients supporting minimum 3x3 MIMO with 3 spatial streams. It must support minimum 3 concurrent MU-MIMO users.</td>
</tr>
<tr>
<td>3</td>
<td>Should support minimum 16x BSSID per AP. Should have compatibility to work in atmospheric temperature range -5 degree C to 50 degree C.</td>
</tr>
<tr>
<td>4</td>
<td>The access point should be capable of performing security scanning and serving clients on the same radio. It should be also capable of performing RF analysis and security scanning</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>5</td>
<td>Maximum conducted transmit power shall be 24.7 dBm on both 2.4 and 5 GHz with two antennas and EIRP complying to regulatory requirements. The External antenna gain proposed should be minimum 8 dBi or above on both the bands. Should support 20,40 and 80 MHz Channels.</td>
</tr>
<tr>
<td>6</td>
<td>AP should support band steering and load balance across bands and AP’s. The access point or the controller should be capable of running a local DHCP Server.</td>
</tr>
<tr>
<td>7</td>
<td>Security mechanisms should be in place to protect the communication between the Access Point controller and the Access Points.</td>
</tr>
<tr>
<td>8</td>
<td>The access point should support WPA2 enterprise authentication and AES/CCMP encryption.</td>
</tr>
<tr>
<td>9</td>
<td>AP should support 802.11k for Radios Resource management and 802.11r for fast roaming.</td>
</tr>
<tr>
<td>10</td>
<td>Implement Wi-Fi alliance standards WMM, 802.11d, 802.11h and 802.11e and should support VoWLAN.</td>
</tr>
<tr>
<td>11</td>
<td>AP must support L7 Application Identification and spectrum analysis functions.</td>
</tr>
<tr>
<td>12</td>
<td>AP should support Minimum -90dB Receiving sensitivity. AP should support Receiver sensitivity Threshold to reduce noise reception in the AP to increase SNR and performance.</td>
</tr>
<tr>
<td>13</td>
<td>802.11 a/b/g/n/ac wave 2 functionality certified by the Wi-Fi alliance, Should be IP67 rated and RF transmission power should be approved by WPC.</td>
</tr>
<tr>
<td>14</td>
<td>AP should support up to 100-mph sustained winds and up to 165-mph wind gusts</td>
</tr>
<tr>
<td>15</td>
<td>Should have direct OEM 24x7x365 TAC support with software update and NBD advanced hardware replacement warranty.</td>
</tr>
</tbody>
</table>

### Router

<table>
<thead>
<tr>
<th>S. N.</th>
<th>TECHNICAL SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Router should be a modular aggregation platform. It should support broadband aggregation for voice, video, data, and mobility services with QoS scaling to a large number of queues per device.</td>
</tr>
<tr>
<td>2</td>
<td>Router should have 8 nos. of 10/100/1000 Base-T ports and 4 nos. SFP based ports.</td>
</tr>
<tr>
<td>3</td>
<td>Router should have at least 1 open slots for additional LAN/ WAN modules other then asked ports.</td>
</tr>
<tr>
<td>4</td>
<td>Router should have 4x10 Gigabit SFP+ ports from day 1</td>
</tr>
<tr>
<td>5</td>
<td>Router should have minimum 4 GB RAM from day 1.</td>
</tr>
<tr>
<td>6</td>
<td>Router should have DES, 3DES and AES Standards through dedicated encryption module/processor. Should support IPSec with IKEv2 and Suite-B Encryption</td>
</tr>
<tr>
<td>7</td>
<td>Router shall have hot swappable 1:1 redundant internal power supply</td>
</tr>
<tr>
<td>8</td>
<td>Router should have a minimum performance of 15 Mpps and 10 Gbps of bandwidth, Scalable to 20 Gbs in future.</td>
</tr>
<tr>
<td>9</td>
<td>Router should support static Routes, OSPFv2, OSPFv3, BGP4, MBGP, BFD, Policy based routing, IPv4 and IPv6 tunneling, MPLS LDP, MPLS L3VPN, MPLS L2VPN , MPLS TE, FRR Link &amp; Node Protection, LDP, MPLS Static label, MPLS VRF-aware static labels, LDP - Session Protection, LDP - Graceful Restart, MPLS L2VPN Pseudo wire Redundancy with TE/FRR protection, Support for QinQ to Ethernet/VLAN Ethernet/IP interworking, MPLS VPN - Carrier Supporting Carrier (CsC), CsC with IPv4 BGP label distribution (RFC 3107)</td>
</tr>
</tbody>
</table>
10. Router should support IGMP v1/v2/v3 and PIM multicast routing

11. Should support other IP Services like GRE tunnel, IPv4 tunnel, IPv6 tunnel, Virtual Router Redundancy Protocol (VRRP), Network Address Translation (NAT), Access Control Lists (ACLs)

12. Shall have 802.1p class of service, IP differentiated service code point (DSCP) and IP precedence.

13. Routers should support marking, classification, policing and shaping, Hierarchical QoS for Traffic Management inspections, QoS classification with TCP Application traffic. The router shall provide up to 16k queues for deployment of per-user per-application per-port QoS.

14. Router should support SSHv2, SNMPv2c, SNMPv3, NTPv3 or/and NTPv4 (if available with OEM)

15. Routers should support AAA using RADIUS and TACACS+

16. Support for accounting of traffic flows for network planning and security purposes. Router shall provide application recognition through analysis of flows.

17. Support for accounting of traffic flows for network planning and security purposes. Router shall provide application recognition through analysis of flows.

18. Router should support monitoring of network traffic with application level insight with deep packet visibility into web traffic, RTP-Based VoIP traffic and cRTP

19. Router shall have traffic load balancing capability on dual WAN Links based on advanced criteria, such as reachability, delay, loss, jitter and bandwidth utilization.

20. Router / Router’s Operating System should be tested and certified for EAL 4 or above under Common Criteria Certification

21. Router should be IPv6 Certified/IPv6 logo ready

22. Router should have direct OEM TAC support and hardware replacement warranty.

1.4. Testing & Commissioning:

All Active components shall have the OEM test reports and shall have direct OEM warranty/Guarantee support for hardware replacement and for software operational related issues. All equipment’s installation shall be considered completed after verifying all the features of the system as mentioned in the specifications and as per the standards.

All equipment shall be replaced if there is any fault in the hardware or in software within two to three hours. The Agency shall supply the spares of the main equipments in the stock so that the work of the complex shall remain smooth & undisturbed. All equipment’s installation shall be considered completed after verifying all the features of the system as mentioned in the specifications in the Tender and as per the standards.

2. IPABX SYSTEM

IP Based Central IPABX of initially capacity of 2000 Telephones & expandable up to 10000 telephones shall be located at a central location in the Hospital OPD block at AIIMS Guwahati. All the Telephone in the Complex will be IP Based and will use the existing LAN Network for the communication within the complex as well as for outside the complex. All Rack Panels of Individual buildings shall be connected to Central EPABX system through Optical Fiber Cable to be laid underground in HDPE Pipe of suitable size. Manholes with covers shall be provided in the underground HDPE pipe at suitable lengths for easy pulling & maintenance of cables. 20% LAN switches shall be provided as spare as required & as per directions of E-I-C.

Type of IP Phones shall be provided as detail given below as per directions of Engineer In Charge:-
1. Type -4 IP Phone – President, Director, Medical Superintendent, Dean, Principal, Auditorium Conference Room, Office in Directors Residence, etc.
2. Type -3 IP Phone – HODs, Chairman, Conference Room etc.
3. Type -2 IP Phone – Guest House, Security room, Server Room, Fire Control Room, etc.
4. Type-1 IP Phone – All Residential Blocks, Hostels, Night Shelter, cafeteria, Dining Block, Fire Station, ESS, Mortuary, Laundry, WTP, ETP, STP etc.

2.1. The following are the specifications for the proposed IPABX System for the AIIMS Guwahati:

2.1.1. **IPABX Hardware:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Feature description</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processors</td>
<td>Each server shall have a minimum of two (2) Intel E5-2600 series CPUs and supports the Intel E5-2697 v2 2.70 GHz 130 W CPU</td>
<td>Offers the latest technology</td>
</tr>
<tr>
<td>Storage</td>
<td>The server should have up to 24 front-accessible, hot-swappable, SAS, SATA or SSD drives</td>
<td>Offers more options for local storage, providing redundancy options and ease of serviceability</td>
</tr>
<tr>
<td></td>
<td>The Server RAID controller should support the following configurations RAID 0, 1, 5, 6, 10, 50, and 60</td>
<td>Provides redundancy options and ease of serviceability</td>
</tr>
<tr>
<td></td>
<td>Should support a write cache of 1 GB for the storage controller</td>
<td>To meet the demands of disk intensive applications</td>
</tr>
<tr>
<td></td>
<td>Support for a battery back write cache for the storage controller</td>
<td>Increase data reliability and integrity</td>
</tr>
<tr>
<td></td>
<td>Must have an internal slot for SD card / Flash which supports booting hypervisors</td>
<td>Offers more internal storage options for HITES to choose from</td>
</tr>
<tr>
<td>Memory</td>
<td>Should have at least 24 DIMM slots for up to 768 GB of DDR3 memory using 32 GB DIMMs</td>
<td>To meet most typical server requirements</td>
</tr>
<tr>
<td></td>
<td>Support for advanced memory redundant technologies like Advanced error-correcting code (ECC) and memory mirroring</td>
<td>Flexibility, increased performance, and compatibility with industry standards</td>
</tr>
<tr>
<td>Network</td>
<td>Should have 2 * 1 GbE LAN on Motherboard (LOM) for network connectivity</td>
<td>Offers network connectivity without using any of the PCIe expansion slots</td>
</tr>
<tr>
<td></td>
<td>The server should support the technology of 10-Gbps unified network fabric which aggregates both the Ethernet and FC connectivity on a single controller using Low-latency, lossless, 10-Gbps Ethernet and industry-standard Fiber Channel over Ethernet (FCoE) fabric</td>
<td>Fewer interface cards, cables, and upstream network ports to purchase, power, configure, and maintain</td>
</tr>
<tr>
<td>PCIe Slots</td>
<td>Each server should offer 5 PCI Express (PCIe) 3.0 slots</td>
<td>Flexibility, increased performance, and compatibility with industry standards</td>
</tr>
<tr>
<td></td>
<td>● 2 x 16x both full height, one half length &amp; the other 3/4 length</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● 2 x 8x both full-height and one is half-length</td>
<td></td>
</tr>
<tr>
<td></td>
<td>● 1 x 8x half height half length</td>
<td></td>
</tr>
<tr>
<td>Management</td>
<td>The integrated management controller should support web user interface for server management; remote keyboard, video, and mouse (KVM); virtual media; and administration with Virtual media support for remote KVM and CD and DVD drives as if local</td>
<td>Simplified and easier management</td>
</tr>
</tbody>
</table>
The server should support Intelligent Platform Management Interface (IPMI) 2.0 support for out-of-band management through third-party enterprise management systems. Follows industry standard.

The server should support Command-line interface (CLI) for server management. Follows industry standard and offers a choice for the administrators.

**Ports**
- Should have the following ports for server connectivity:
  - 1 serial port
  - 2 USB ports
  - 1 VGA video port

**Others**
- Supports hot swappable redundant fans. Builds capability for enterprise-class reliability and uptime.
- Supports hot swappable redundant power supplies. Builds capability for enterprise-class reliability and uptime.

**Environmental**
- Operating Temperature support from 23°F to 104°F (-5°C to 40°C) and Non operating Temperature from -40°F to 149°F (-40°C to 65°C). Wide range of operating environments.
- Operating Humidity from 10 to 90% non condensing. Wide range of operating environments.
- Operating Altitude from 0 to 10,000 ft (0 to 3000m) and Non operating Altitude up to 40,000 ft (12,000m). Wide range of operating environments.

### 2.1.2. Exchange Software:

The network will have SIP based call control architecture with call control functionality centralized or distributed across multiple nodes across WAN for enhanced redundancy.

**General Specifications for Solution**
- A comprehensive IP based solutions based on a Server Gateway Architecture.
- Support for integrated telephony solution for Video conferencing devices, Analog & IP Phones, PSTN gateways over IP architecture.
- The solution should offer executive users the ability to use their video device outside of the enterprise (Internet) to make audio and video calls with or without VPN.
- The solution should allow for business to business (B2B) video calls using SIP, H.323 with other organizations without bypassing existing firewalls. At least 5 concurrent video calls @720p30 should be allowed from day one.
- The solution should allow provisioning of gateways with redundant power supplies.
- Call Control, MCU and IP Phones should be from the same OEM for better interoperability and user experience.
- The OEM and bidder should be profit making entity.
- The acceptable makes of the offered equipment for IP PBX, IP Phones and UC clients shall be as per Leader’s quadrant of Gartner’s magic quadrant for unified communications from the latest publication of Gartner.

**System Architecture**
- The call control system should be fully redundant solution with NO single point of failures & should provide 1:1 redundancy. Both the server should do call processing all the time and act as backup in case of the failure of one server and must be deployed in High Availability mode.
- The call control should support clustering over WAN
- The proposed system should be Integratable with ACD, IVR
- The call control system should support IPv4 and IPv6 from day one.
- The system should natively support tenant partitioning so as to comply with TRAI regulations for not allowing VoIP (CUG calls) and PSTN calls to be bridged. Any third party applications to manage tenant partitioning should not be quoted in the architecture.
The proposed call control server should provide support for standards based SIP IP Phones (Wired & Wireless), Analog Phones, Video Phones, Video Conferencing endpoints and soft clients to provide centralized management and unified dial plan.

Conference Bridge—provides software conference bridge resources that can be used by IP EPABX.

The system should support an inbuilt reporting tool for calls. Reports that are provided include Calls on a user basis, Calls through gateways, Simplified Call Quality.

Should support signalling standards/Protocols – SIP, MGCP, H.323, Q.Sig.

CODEC support - G.711, G.729, G.729ab, g.722, iLBC

The system should provide the ability to perform tasks in bulk i.e. Add, Remove, Update users, phones, gateways, dial plan etc.

The system should support creation of users and their authentication locally and via an integration with LDAP.

The system should support call admission control to configure number of calls that can be active between locations – intercluster and intracluster.

Call preservation – redundancy and automated failure – on call-processing failure. In progress PSTN calls at each of the locations should not be interrupted in the event of any WAN failure or call control server failure.

Open API should be provided when required which will help to develop customized IP applications which will integrate with call processing.

It is required to provide Survivable Call Control functionality so that the survivable system at the remote location i.e. Media Gateway shall provide fall back call control service in case the remote site loses all connectivity to the main Call Control system placed. It is expected that the survivability call control system will provide a minimal set of essential telephony features to the end-users that could be a subset of the feature that are available from the main call control system.

The call control system must support all types of phones required by AIIMS Guwahati

**Security**

All the appliances in the call control system should have dual redundant and hot swappable power supply and fans for high availability.

All appliances in the call control system should have hot swappable storage media to ensure high availability.

Support for configuration database (contains system and device configuration information, including dial plan)

Having inbuilt administration web based administration. No additional thick client for administration on the Admin PC. Should also support HTTPS for management.

Access to the system should be secure for the purpose of access over IP network. The protection of signaling connection over IP by means of authentication, Integrity and encryption should be carried out using TLS.

There should be provision of defining password aging, one time passwords. Provision shall be available to bar unauthorized user to connect to the system. The system should monitor and report the following types of security

\ violation login Violations, authorization code violation Station security code violations etc.

IP Phones should not support direct, external initiated, connections via HTTP, telnet, FTP, TFTP or any other protocol as means to prevent distributed Denial of Service attack exploitation, except those required for routine firmware upgrades.

Role Based Account Management to define different levels of administrator access depending on specific function responsibility

The system should support complete encryption capabilities with the ability to encrypt all traffic (media and call control signaling) between IP phones, soft phones, call controllers, gateways and all other associated endpoints using a strong encryption algorithm (AES, IPSec and SRTP, for example).

All management traffic between the remote console/session and control server should be encrypted (SSH for Direct Command Line Sessions, Interface, HTTPS (SSL) for Web Sessions, SFTP for File Transfer Etc.).

Should support SSL for LDAP directory integration.

All Hardware & Software with license required for providing above Security measures must be incorporated.

**System Capabilities Summary**

The System should have IP capability for interfacing & Communicating with Voice, Video and Data infrastructure
The architecture should support a minimum of 1500 IP phones and VC systems per Server from day one.

The architecture should support single Server Clustering to provide scalability to offer support for 40,000 users and also to provide redundancy. All the 40,000 users to be managed in a single database which is managed centrally, no multiple databases.

The System should support Alternate Call Routing

The System should have GUI support web based management console

System backups: The management system should have the provisioning for taking manual as well as scheduling of automatic periodic backup of complete system & data.

The System should support Audio message-waiting indicator (AMWI)

The System should have Automated bandwidth selection

Should support SNMP v2, v3

It should be possible to monitor the call control system i.e. system performance, device status, device discovery, CTI applications, voice messaging ports etc.

**IM & Presence**

Solution should provide a “presence” application for users, so that they can see the availability status of their contacts in their contact list.

The common supported status for this application should be available, busy, idle, away etc.

Should support the users to see other user’s IP phone’s on/off hook states

The instant messaging application should support manual setting of user status to: Available, Away, Do Not Disturb (DND) etc.

Shall provide support for open protocols like XMPP.

Presence based desktop application shall allow escalation of Instant Message to Audio call and further to Video call

Should support management of contact list and personal settings from Presence based desktop application

Should support click to call, click to Video and click to conference features.

The Soft Client should have soft phone capability and should support desktop and iPad based point to point video calls.

**Video Telephony Support**

The call control system should provide integrated video telephony features to the users so that user with IP Phone / Soft phone and video telephony end point should be able to place video calls with the same user model as audio calls.

The solution must support escalation of point to point video calls to Multiparty video calls using the central MCU without disconnecting the call.

The users should be able to transfer video calls as audio calls

Call-Server should provide a common control agent for signaling, configuration, and serviceability for voice or video end points.

Call control system should handle CODEC and video capabilities of the endpoints, bandwidth negotiation to determine if video/audio call can take place.

**End user Features required:**

Extension mobility

Call forward all

Message-waiting indicator (MWI)

Privacy

Device mobility

Do not disturb

Hunt groups

Dial-plan partitioning

Distributed call processing

Deployment of devices and applications across an IP network

“Clusters” of Call-Servers for scalability, redundancy, and load balancing

Inter cluster scalability to 100+ sites or clusters through H.323 gatekeeper
Fax over IP—G.711 pass-through and Fax Relay
Forced authorization codes and client matter codes (account codes)
H.323 interface to selected devices
Hotline and private line automated ring down (PLAR)
Interface to H.323 gatekeeper for scalability, CAC, and redundancy
Language support for client user interfaces (languages specified separately)
Multi-Level Precedence and Preemption (MLPP)
Multi location—dial-plan partition
Multiple ISDN protocol support
Multiple remote Call Server platform administration and debug utilities
Prepackaged alerts, monitor views, and historical reports with Real Time Monitor Tool (RTMT).
Real-time and historical application performance monitoring through operating system tools and Simple Network Management Protocol (SNMP)
Remote terminal service for off-net system monitoring and alerting
Real-time event monitoring and presentation to common syslog
Trace setting and collection utility
Cluster wide trace setting tool.
Trace Collection tool.
Multisite (cross-WAN) capability with intersite CAC
Q.SIG (International Organization for Standardization [ISO])
Video calls to be placed with the same user model as audio calls.
Call-Server should support new video end points.
SIP Video endpoints which should inherit the functionality of audio calls which gives the user the same call model for both video and audio calls.
Call-Server should have the infrastructure to handle codec and video capabilities of the endpoints, bandwidth negotiation to determine if video/audio call can take place, single point of administration, management of media devices such as gateways and MCUs.
Call-Server should provide a common control agent for signaling, configuration, and serviceability for voice or video end points.

2.1.3. **Type -1 IP Phone:**

**Type -1 IP Phone**
The phone should support at least 1 line.
It should support the following codec G.711a/μ, G.729a
It should have graphical display with a minimum resolution of 128 x 32 pixels
The phone should support QoS mechanism through 802.1p/q.
Should have built-in high-quality full-duplex speakerphone
Should include audio controls for the full-duplex speakerphone and handset.
IP address Assignment by DHCP or statically configured
The Phone should support the ability to provide different ringtones for internal and external calls.
Should have volume control button for easy decibel-level adjustments for the speakerphone, handset and ringer.
The phone should support mounting against a wall
The phone should support IPv4 and IPv6 from day one.
The phone should support Power over Ethernet IEEE 802.3af class 1/2/3 and should also have AC power adapter option
The phone should be a SIP based Phone i.e. session Initiation protocol (SIP) supported
The phone should provide basic 3-way conferencing
The phone should support at least 50 entries for call history i.e. missed, received, placed etc.

Should have keys for specific functionalities such as – Redial, settings, transfer, speakerphone, mute on/off, hold/resume

Should have 4 MB flash memory and 30 MB or more SDRAM.

2.1.4. **Type -2 IP Phone:**

<table>
<thead>
<tr>
<th>Type -2 IP phone</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The phone should support Power over Ethernet IEEE 802.3af class 1/2/3 and should also have AC power adapter option.</strong></td>
</tr>
<tr>
<td><strong>Should feature a LCD display of at least 3.5” for information such as calling party name, calling party number, and digits dialed to be displayed.</strong></td>
</tr>
<tr>
<td><strong>The phone should have two Ethernet ports of at least 10/100/1000 BASE-T Ethernet ports, one for the LAN connection and the other for connecting to PC/laptop.</strong></td>
</tr>
<tr>
<td><strong>Corporate directory and Lightweight Directory Access Protocol (LDAP) integration.</strong></td>
</tr>
<tr>
<td><strong>Ready access to missed, received or placed calls (plus intercom history and directories).</strong></td>
</tr>
<tr>
<td><strong>The phone should support QoS mechanism through 802.1p/q.</strong></td>
</tr>
<tr>
<td><strong>IP address Assignment by DHCP or statically configured.</strong></td>
</tr>
<tr>
<td><strong>Hands-free operation with full-duplex speaker-phone.</strong></td>
</tr>
<tr>
<td><strong>The phone should be a SIP based Phone i.e. session Initiation protocol (SIP) supported.</strong></td>
</tr>
<tr>
<td><strong>The phone should support XML based services and applications.</strong></td>
</tr>
<tr>
<td><strong>The phone should have a distinct LED indicator for message waiting.</strong></td>
</tr>
<tr>
<td><strong>Should have keys for specific functionalities such as – voicemail, directories, settings, transfer, speakerphone, mute on/off, headset etc</strong></td>
</tr>
<tr>
<td><strong>Media Encryption (SRTP) using AES.</strong></td>
</tr>
<tr>
<td><strong>Signaling Encryption (TLS) using AES.</strong></td>
</tr>
<tr>
<td><strong>Should support 802.1x.</strong></td>
</tr>
<tr>
<td><strong>Encryption of Configuration Files.</strong></td>
</tr>
<tr>
<td><strong>The phone should have the ability to register to call control server over an internet link with or without VPN.</strong></td>
</tr>
<tr>
<td><strong>The phone should support IPv4 and IPv6 from day one.</strong></td>
</tr>
<tr>
<td><strong>The phone should support at least 100 entries for call history i.e. missed, received, placed etc.</strong></td>
</tr>
<tr>
<td><strong>It should support the following codecs: G.711a/μ-law, G.722, G.729a, iLBC.</strong></td>
</tr>
<tr>
<td><strong>The phone should have RJ9 headset port to connect any standards based headset. The phone should also have a separate headset key.</strong></td>
</tr>
<tr>
<td><strong>The phone also includes the following settings - Display contrast, Ring type, Network configuration, Call status.</strong></td>
</tr>
<tr>
<td><strong>The Phone should support the ability to provide different ringtones for internal and external calls.</strong></td>
</tr>
<tr>
<td><strong>Should have volume control button for easy volume adjustments for the speakerphone, handset and ringer.</strong></td>
</tr>
<tr>
<td><strong>The phone should support mounting against a wall.</strong></td>
</tr>
<tr>
<td><strong>The phone should support 4 programmable lines keys.</strong></td>
</tr>
<tr>
<td><strong>The phone should the following features:</strong></td>
</tr>
<tr>
<td><strong>i. Call forward</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>ii.</td>
</tr>
<tr>
<td>iii.</td>
</tr>
<tr>
<td>iv.</td>
</tr>
<tr>
<td>v.</td>
</tr>
<tr>
<td>vi.</td>
</tr>
<tr>
<td>vii.</td>
</tr>
<tr>
<td>ix.</td>
</tr>
<tr>
<td>x.</td>
</tr>
<tr>
<td>xi.</td>
</tr>
<tr>
<td>xii.</td>
</tr>
<tr>
<td>xiii.</td>
</tr>
<tr>
<td>xiv.</td>
</tr>
<tr>
<td>xv.</td>
</tr>
</tbody>
</table>

### 2.1.5. **Type -3 IP Phone -Video:**

<table>
<thead>
<tr>
<th>Type -3 IP Phone –Video</th>
</tr>
</thead>
<tbody>
<tr>
<td>The phone should support Power over Ethernet IEEE 802.3af class 1/2/3 and should also have AC power adapter option</td>
</tr>
<tr>
<td>The phone should have 2 x 1GE ports, one for the LAN connection and the other for connecting to PC/laptop.</td>
</tr>
<tr>
<td>Ready access to missed, received or placed calls (plus intercom history and directories).</td>
</tr>
<tr>
<td>The phone should support QoS mechanism through 802.1p/q.</td>
</tr>
<tr>
<td>IP address Assignment by DHCP or statically configured</td>
</tr>
<tr>
<td>Hands-free operation with full-duplex speaker-phone</td>
</tr>
<tr>
<td>The phone should be a SIP based Phone i.e session Initiation protocol (SIP) supported</td>
</tr>
<tr>
<td>The phone should support XML based services and applications.</td>
</tr>
<tr>
<td>The phone should have a distinct LED indicator for message waiting.</td>
</tr>
<tr>
<td>Should have keys for specific functionalities such as – voicemail, directories, settings, transfer, speakerphone, mute on/off, headset etc</td>
</tr>
<tr>
<td>Media Encryption (SRTP) using AES</td>
</tr>
<tr>
<td>Signaling Encryption (TLS) using AES</td>
</tr>
<tr>
<td>802.1x support</td>
</tr>
<tr>
<td>Encryption of Configuration Files</td>
</tr>
<tr>
<td>The phone should have the ability to register to call control server over an internet link with or without VPN.</td>
</tr>
<tr>
<td>The phone should support IPv4 and IPv6 from day one.</td>
</tr>
<tr>
<td>Should have min 5&quot; screen with colour display with at least 4 programmable line keys</td>
</tr>
<tr>
<td>The phone should support backlit indicators for the audio path keys (handset, headset, and speakerphone), select key, line keys, and message waiting.</td>
</tr>
<tr>
<td>Should support following audio codec - G.711a, G.711u, G.729a, G.722, iSAC, Internet Low Bitrate Codec (iLBC)</td>
</tr>
<tr>
<td>The phone should have RJ9 headset port to connect any standards based headset. The phone should also have a separate headset key</td>
</tr>
</tbody>
</table>
Should have a built-in camera with 720p resolution (encode & decode). The camera should have a shutter to open/close camera. Should support standards based video protocol H.264

Should support self-view video, picture in picture (pip) with adjustable positions of pip.

Should support Bluetooth (v4.1 LE) for hands free earphones

Should support Call history synchronization to view placed and missed calls of mobile device from the IP Phone

The phone should support mounting against a wall

The phone should support at least 100 entries for call history i.e. missed, received, placed etc.

Should support busy lamp indicator (BLF) to indicate the presence

Should support boss-secretary feature, so that secretary can answer calls on behalf of Manager

The smartphone should support the following features at a minimum:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Call forward</td>
<td></td>
</tr>
<tr>
<td>b. Call pickup</td>
<td></td>
</tr>
<tr>
<td>c. Call waiting</td>
<td></td>
</tr>
<tr>
<td>d. Call back</td>
<td></td>
</tr>
<tr>
<td>e. Call park</td>
<td></td>
</tr>
<tr>
<td>f. Conference</td>
<td></td>
</tr>
<tr>
<td>g. Extension Mobility</td>
<td></td>
</tr>
<tr>
<td>h. Auto answer</td>
<td></td>
</tr>
<tr>
<td>i. Auto-detection of headset</td>
<td></td>
</tr>
<tr>
<td>j. Immediate Divert</td>
<td></td>
</tr>
<tr>
<td>k. Music on hold (MoH)</td>
<td></td>
</tr>
<tr>
<td>l. SIP URI dialing</td>
<td></td>
</tr>
<tr>
<td>m. URL Dialing</td>
<td></td>
</tr>
<tr>
<td>n. Message waiting indicator (MWI)</td>
<td></td>
</tr>
<tr>
<td>o. Personal directory</td>
<td></td>
</tr>
<tr>
<td>q. Call history lists</td>
<td></td>
</tr>
</tbody>
</table>

2.1.6. Type -4 Executive IP Video Phone:

**Type -4 Executive IP Video Phone**

**Specifications for the Personal Video conferencing system for executives.**

Should be an integrated system with at least 22 to 24 inch LCD/TFT screen, **1080P resolution** (16:9), HD camera and with speakers for wide band audio output. The Codec should be a part of the unit. No separate Codec’s are preferred.

The LCD/TFT screen should be a touch screen to provide a touch interface to the user.

<table>
<thead>
<tr>
<th>Features</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Must support IPv4 and IPv6 from day one.</td>
</tr>
<tr>
<td></td>
<td>Must have the following physical buttons for ease of use</td>
</tr>
<tr>
<td></td>
<td>1. Mute/ Unmute</td>
</tr>
<tr>
<td></td>
<td>2. Volume Increase/ decrease</td>
</tr>
<tr>
<td><strong>Video</strong></td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>-----------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Video Standards</strong></td>
<td>Minimum H.264 and above</td>
</tr>
<tr>
<td></td>
<td>The system should support SIP protocol.</td>
</tr>
<tr>
<td></td>
<td>Must support desktop sharing SIP calls</td>
</tr>
<tr>
<td><strong>Video Frame Rate</strong></td>
<td>Must support 1080p 30 fps</td>
</tr>
<tr>
<td><strong>Video Features</strong></td>
<td>Ability to send and receive two live simultaneous video sources in a single call.</td>
</tr>
<tr>
<td></td>
<td>The unit must support layout control for video and presentation on a single LCD screen.</td>
</tr>
<tr>
<td><strong>Video Input</strong></td>
<td>Should have HDMI or DVI (Digital Video Interface) input to connect PC/ Laptop directly to the Video conferencing system and display a resolution of XGA/SXGA.</td>
</tr>
<tr>
<td></td>
<td>The user must be able to toggle between the Laptop/PC mode and the Video conferencing mode at a push of button/icon.</td>
</tr>
<tr>
<td><strong>Video Resolution</strong></td>
<td>CIF (352 x 288 pixels)</td>
</tr>
<tr>
<td></td>
<td>VGA, 240p, 360p, 480p</td>
</tr>
<tr>
<td></td>
<td>720p (1280 x 720 pixels)</td>
</tr>
<tr>
<td></td>
<td>1080p (1920x1080 pixels)</td>
</tr>
<tr>
<td><strong>Dual Stream</strong></td>
<td>Must support H.239 and BFCP for resolutions upto 1080p</td>
</tr>
<tr>
<td><strong>Firewall Traversal</strong></td>
<td>Should support firewall traversal solution using the H.460.18 and H.460.19 protocol.</td>
</tr>
<tr>
<td><strong>Audio</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Audio System</strong></td>
<td>The system should have two stereo front speakers with inbuilt microphones, wideband speakers.</td>
</tr>
<tr>
<td></td>
<td>G.722, G.711, MPEG 4 AAC or better - which supports 20 KHz audio must be supported</td>
</tr>
<tr>
<td><strong>Other Features</strong></td>
<td>Noise Reduction/Echo Cancellation, Automatic Gain control, Automatic Audio mixer</td>
</tr>
<tr>
<td></td>
<td>Must support escalation of point to point calls to Multiparty calls using the central MCU without disconnecting the call.</td>
</tr>
<tr>
<td><strong>Network Interfaces</strong></td>
<td></td>
</tr>
<tr>
<td><strong>LAN</strong></td>
<td>1 x LAN /Ethernet--10/100/1000</td>
</tr>
<tr>
<td></td>
<td>1 x LAN /Ethernet--10/100/1000 to connect a PC (i.e. built in switch)</td>
</tr>
<tr>
<td><strong>Wi-Fi</strong></td>
<td>Must support 802.11a/b/g/n</td>
</tr>
<tr>
<td><strong>Bluetooth</strong></td>
<td>Must support bluetooth 3.0 for connecting bluetooth headsets</td>
</tr>
<tr>
<td><strong>SIP/H.323/ IP Features</strong></td>
<td>Must support Standard based Packet loss recovery algorithm to handle packet loss.</td>
</tr>
<tr>
<td></td>
<td>QOS</td>
</tr>
<tr>
<td></td>
<td>Should support URI Dialing</td>
</tr>
<tr>
<td></td>
<td>Must support SIP and H.323</td>
</tr>
<tr>
<td><strong>Data Collaboration</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Presentation through presence of DVI/HDMI Input port</td>
</tr>
<tr>
<td></td>
<td>The system must have the ability to pair mobile devices such as Tablets and Smart phones based on iOS or Android platforms so that these devices can be used for: 1) View the Presentation that is being shown in the VC call. 2) Add and disconnect call, move the call from mobile device to/ from video unit. The system must have the ability to pair with laptop for sending content without any wires to the video unit. In case the above feature is not available natively, then additional components can be provided to achieve this functionality.</td>
</tr>
</tbody>
</table>
Security

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Password protected system menu</td>
<td></td>
</tr>
<tr>
<td>Meetings both point and point and multipoint, should be password protected and the same should be possible for SIP networks</td>
<td></td>
</tr>
<tr>
<td>Call should be encrypted end-to-end on IP calls</td>
<td></td>
</tr>
<tr>
<td>The unit must support the option of disabling the secondary network port if not in use.</td>
<td></td>
</tr>
</tbody>
</table>

Camera

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Should be HD at least 6 megapixel camera, with privacy shutter</td>
<td></td>
</tr>
<tr>
<td>Must support 1080p resolution.</td>
<td></td>
</tr>
<tr>
<td>60 degrees horizontal Field of View</td>
<td></td>
</tr>
<tr>
<td>35 degrees vertical field of view</td>
<td></td>
</tr>
<tr>
<td>Must have a privacy shutter</td>
<td></td>
</tr>
<tr>
<td>The VC unit must allow the camera to be used as a document camera to capture hard copies and transmit it to the far end site.</td>
<td></td>
</tr>
</tbody>
</table>

Directory Services

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Should support Local and Global directories</td>
<td></td>
</tr>
<tr>
<td>Should support LDAP and H.350 protocols for directory transfer.</td>
<td></td>
</tr>
</tbody>
</table>

2.1.7. Meeting Server:

Specifications for High Definition Multipoint Control Unit (MCU)

**MCU must be standards based and meet the following specifications:**

<table>
<thead>
<tr>
<th>S No.</th>
<th>Feature</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>General</td>
<td>The MCU should be running on standard intel servers on standard Virtualized platforms. The hardware, software and virtualization software should be supplied and supported by a single bidder.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All necessary hardware to support the required capacity needs to be supplied from day one. Each of the server supplied for the MCU must have a redundant power supply from day 1.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The MCU must have 25 Full HD ports @1080p 30 fps with H.264 AVC and Continuous presence from day one.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All the 25 ports must be able to connect different sites at different bandwidths and protocols. H.264 AVC standard must be supported at the minimum to connect all the 25 devices.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The MCU must be able to host at least 4 simultaneous conferences each having different capacities restricted by the maximum port capacity of the MCU</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The MCU must also support HD mode and it must provide a capacity of connecting at least 50 sites @720p30 fps</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MCU should be capable of supporting participants using various means i.e. via video enabled phones, room based video endpoints, soft clients on mobile/tablet or via the browser using WebRTC compatible browsers in a single conference. The meeting quality has to be consistent and of high quality. The end points can be present on the WAN network or on the internet. In case additional components are required for this</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>Functionality, all additional components required to have this functionality has to be included in the solution</td>
<td>The MCU should have the capability to host meetings with internal and external participants in a secure way such that it should co-exist with the enterprise security policies</td>
</tr>
<tr>
<td></td>
<td>The MCU should support H323 and SIP protocols.</td>
<td>The MCU should support geographical redundancy, so that MCU could be placed in DC/DR setup in case future expansion is needed.</td>
</tr>
<tr>
<td></td>
<td>The MCU should support H323 and SIP protocols.</td>
<td>The MCU must support the concept of virtual meeting rooms to users who Hosts meeting frequently. Such meeting rooms should support dialing in from standard based video end points, internal and external users and browser based clients. The system should allow one Virtual meeting room per employee, however it should not consume resources when not in use.</td>
</tr>
<tr>
<td></td>
<td>The MCU should be able to maintain the dynamic resource allocation capacity for 1080p, 720p and SD participants simultaneously without having to reboot or change any configuration.</td>
<td>The MCU should support 90 ports or more at HD 720p (transmit and receive) up to 4Mbps on IP in continuous presence mode with 30fps, 1500 audio ports, 50 WebRTC connections and H.264 resolution and AES encryption on the same MCU.</td>
</tr>
<tr>
<td></td>
<td>The administrator should be able to specify maximum resolution for main video and content.</td>
<td>The MCU should display a security icon on the endpoint if the conference is secure.</td>
</tr>
<tr>
<td></td>
<td>Video conferencing endpoints deployed at other organization must be able to take part in video conferencing. The endpoints can be of various makes using open standards.</td>
<td>Interoperability with all organization must be possible using standards based dialling methodology using the Internet.</td>
</tr>
<tr>
<td></td>
<td>Interoperability with all organization must be possible using standards based dialling methodology using the Internet.</td>
<td>The MCU should support on-screen text messaging on video endpoints, so that if there’s a delay in starting a meeting, participants can be informed.</td>
</tr>
<tr>
<td></td>
<td>The MCU should be able to integrated with existing IP PBX to provide audio conferencing ports to phones.</td>
<td>The MCU should be able to integrate with Call Control system using SIP.</td>
</tr>
<tr>
<td>2</td>
<td>Video Standards</td>
<td>Should support H.263, H.263+, H.263++, H.264, H.264 SVC/H.264 High Profile video algorithms</td>
</tr>
<tr>
<td>3</td>
<td>Video Resolution</td>
<td>Should support video resolution from SD to Full HD to join into a conference</td>
</tr>
<tr>
<td></td>
<td>The proposed MCU should be able to combine HD and SD in the same conference without degrading the HD resolution from and to the HD endpoints. The MCU shall interoperate with multiple vendors’ endpoints. The supported mediums should be IPv4 and IPv6.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Audio Standards</td>
<td>Along with the support for basic algorithms like G.711 and G.722.1 the MCU should also support wideband Audio protocols like MPEG 4 AAC - LC and MPEG 4 AAC - LD</td>
</tr>
<tr>
<td>5</td>
<td>Trans coding &amp; Rate Matching</td>
<td>The MCU should support transcoding of different Audio/video Protocols.</td>
</tr>
<tr>
<td></td>
<td>The MCU should be able to combine HD and SD in the same conference without degrading the HD resolution from and to the HD endpoints.</td>
<td>The MCU should be able to combine HD and SD in the same conference without degrading the HD resolution from and to the HD endpoints.</td>
</tr>
</tbody>
</table>
6. **Dual Video**
The MCU should have H.239/BFCP protocol for sending and receiving dual video streams (Presenter + Presentation).

7. **Video Layouts**
At least 16 sites to be seen simultaneously on the screen in traditional Continuous Presence mode.

The MCU must also support advanced continuous presence such that the site that is "on-air" to be seen on a larger window and the other sites are seen in smaller quadrants.

8. **Security**
The MCU must be a secure Non-PC Hardware with a strong operating system. The Hardware and software must be from the same OEM.

The MCU should support 128 Bit strong AES encryption for calls and H.235 for authentication.

The MCU must support encryption for calls on SIP.

9. **Network /USB Interface**
At least 1 LAN/Ethernet--10/100/1000 Mbps full duplex and dedicated serial/USB connection for maintenance/upgrade.

10. **Conference Layout**
MCU Solution should support minimum of 10 layouts

11. **Firewall Traversal**
Should support firewall traversal solution for Business to Business (B2B) Video Calling.

### 2.1.8. PSTN Gateway:

**Hardware Features**
- Should provide 2 X 10/100/1000 interfaces
- Router should have minimum forwarding rate of 1.5 Mpps

- Shall support variety of Voice interfaces like FXO, FXS, BRI, Channelized PRI (E1), E&M and WAN interfaces like V.35 Sync Serial (2 Mbps), Async Serial, E1 G.703, Fast Ethernet, Gigabit Ethernet, ISDN BRI, Channelized and Clear channel E1.

- Should be provided with 4 X E1 Ports Day 1 to terminate 4 PRI lines.

- It should support embedded hardware encryption acceleration, voice/video-capable digital signal processor (DSP) slots or equivalent.

- The gateway should be able to support at least 40 IP Phones in surveivability mode.

- It should support embedded Voice/video-capable digital signal processor (DSP) slots or equivalent feature.

**Protocol Support**
- Shall support Routing protocols like RIP ver1 & 2 OSPF ver2.

- Multicast routing protocols support: IGMPv1, v2, PIM-SM and PIM-DM, DVMRP.


- Shall support IP Accounting features

- Should support crTP to compress voice (RTP) streams

**QoS Features**
- Shall support the following
  - Classification and Marking: Policy based routing, IP Precedence, DSCP, MPLS exp bits
  - Congestion Management: RED, Priority queuing, Class based weighted fair queuing
  - Traffic Conditioning: Committed Access Rate/Rate limiting
  - Per VLAN QoS.

**Security Features:**
Shall support the following

<table>
<thead>
<tr>
<th>AAA support using Radius and/or TACACS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRE</td>
</tr>
<tr>
<td>IPSec</td>
</tr>
<tr>
<td>PAP and CHAP authentication for P-to-P links</td>
</tr>
<tr>
<td>Multiple privilege level authentication for console and telnet access</td>
</tr>
<tr>
<td>Time based &amp; Dynamic ACLs.</td>
</tr>
</tbody>
</table>

**Management**

- Shall have support for management thru Telnet, SSH, Secure Web based management thru HTTPS and SNMPv3 and Out of band management through Console and external modem for remote management
- Should provide a provision to analyze IP service levels for IP applications and services by using active traffic monitoring (the generation of traffic in a continuous, reliable, and predictable manner) for measuring network performance
- Should support flow-based traffic analysis of applications, hosts, performance-based measurements on application and network latency, quality of experience metrics for network-based services such as voice over IP (VoIP) / video.
- Should have the ability to monitor events and take informational, corrective, action when the monitored events occur or when a threshold is reached.

### 3. CLOSED CIRCUIT TELEVISION SYSTEM

The Entire surveillance system is proposed and designed to control and monitors the different buildings of AIIMS Guwahati Campus. 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 6A 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.

### 3.1. CAMERA SPECIFICATIONS-

#### 3.1.1. ONVIF Conformant, UL Listed Day/Night True IP Full HD Infrared Bullet/Dome Camera

<table>
<thead>
<tr>
<th>S.NO.</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>2</td>
<td>Sensor Type</td>
<td>1/1.8” progressive CMOS or Better</td>
</tr>
</tbody>
</table>
### Tech Specs

<table>
<thead>
<tr>
<th>S.N</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Max Resolution: 2560x1920 @ 30 fps &amp; 1080x1920@60fps with H.264/H.265</td>
</tr>
<tr>
<td></td>
<td>2560x1920 @ 12 fps and 1080x1920@30fps with MJPEG</td>
</tr>
<tr>
<td>4</td>
<td>Dynamic Range: 100 dB or Better</td>
</tr>
<tr>
<td>5</td>
<td>Lens/Iris: 4-9mm/P-Iris Remote focus and zoom</td>
</tr>
<tr>
<td>6</td>
<td>Minimum illumination: Color mode: 0.04 lux @ F 1.3</td>
</tr>
<tr>
<td></td>
<td>Black-and-white mode: .001@ f 1.3</td>
</tr>
<tr>
<td>7</td>
<td>Field of View: 45° to 84° (horizontal) 34° to 62° (vertical)</td>
</tr>
<tr>
<td></td>
<td>64° to 113° (diagonal)</td>
</tr>
<tr>
<td>8</td>
<td>Privacy regions: The camera supports up to five user-defined privacy regions.</td>
</tr>
<tr>
<td></td>
<td>Any video within a privacy region is masked in the video stream.</td>
</tr>
<tr>
<td>9</td>
<td>Digital I/O: Digital in x 1 &amp; Digital out x1</td>
</tr>
<tr>
<td>10</td>
<td>Audio I/O: Audio in x 1 &amp; Audio out x 1</td>
</tr>
<tr>
<td>11</td>
<td>Number of streams: Should support at least 3 or more streams simultaneously</td>
</tr>
<tr>
<td></td>
<td>Should support H.265, H.264, or MJPEG video streams simultaneously</td>
</tr>
<tr>
<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: The cameras provide true day/night functionality, and include an</td>
</tr>
<tr>
<td></td>
<td>infrared (IR) 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: Micro SD</td>
</tr>
<tr>
<td>14</td>
<td>Video Compression: H.264 &amp; Motion JPEG and H.265 (Smart Stream)</td>
</tr>
<tr>
<td>15</td>
<td>Open API: ONVIF &amp; profile G &amp; S for standard based interoperability</td>
</tr>
<tr>
<td>16</td>
<td>Shutter speed: 1/5 sec. to 1/32,000 sec</td>
</tr>
<tr>
<td>18</td>
<td>Camera Tamper: The camera should support tamper feature when any of the following events occur and persist for a designated period:</td>
</tr>
<tr>
<td></td>
<td>• The IP camera view is changed</td>
</tr>
<tr>
<td></td>
<td>• The IP camera view is blocked</td>
</tr>
<tr>
<td></td>
<td>• The IP camera view is substantially out of focus</td>
</tr>
<tr>
<td>19</td>
<td>Quality of service (QoS): Differentiated services code point (DSCP) marking and class of service (CoS) marking</td>
</tr>
<tr>
<td>20</td>
<td>Enclosure for Outdoor Bullet Camera: IP67 &amp; IK10 rated Enclosure and Mounting bracket for outdoor mounting</td>
</tr>
</tbody>
</table>

#### 3.1.2. ONVIF Conformat, UL Listed Day/Night IP 66 HD PTZ Outdoor Camera

<table>
<thead>
<tr>
<th>S.N</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Image Sensor: 1/3&quot; Progressive CMOS or Better</td>
</tr>
<tr>
<td></td>
<td>Maximum Resolution: 1920 X1080 (2MP)</td>
</tr>
<tr>
<td>3</td>
<td>Lens type: 30 X Optical Zoom, Auto Focus (30X)</td>
</tr>
<tr>
<td>3</td>
<td>Focal length: f= 4.7 ~ 94 mm</td>
</tr>
<tr>
<td>3</td>
<td>Auto-Iris: DC- Iris</td>
</tr>
<tr>
<td>3</td>
<td>Day/Night: Removable IR-cut filter for day &amp; night function</td>
</tr>
<tr>
<td>3</td>
<td>WDR Technology: WDR Pro, True WDR or Better</td>
</tr>
<tr>
<td>Characteristics</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>Field of View</td>
<td>$3^\circ \sim 55^\circ$ (Horizontal), $2^\circ \sim 33^\circ$ (Vertical)</td>
</tr>
<tr>
<td>Pan Speed</td>
<td>$0.05^\circ \sim 450^\circ$/sec.</td>
</tr>
<tr>
<td>Pan Range</td>
<td>$360^\circ$</td>
</tr>
<tr>
<td>Tilt Speed</td>
<td>$0.05^\circ \sim 450^\circ$/sec.</td>
</tr>
<tr>
<td>Tilt Range</td>
<td>$220^\circ (-110^\circ \sim +110^\circ)$</td>
</tr>
<tr>
<td>Video Compression</td>
<td>H.264, H.265 &amp; MJPEG</td>
</tr>
<tr>
<td>Maximum frame rate</td>
<td>$30$ fps @ $1920 \times 1080$ in all compression mode</td>
</tr>
<tr>
<td>Local Storage</td>
<td>Micro SD</td>
</tr>
<tr>
<td>Maximum Stream</td>
<td>Four simultaneously Streams</td>
</tr>
<tr>
<td>Audi Capability and Compression</td>
<td>Full duplex Audio and G.711, G.726 Compression codecs</td>
</tr>
<tr>
<td>ONVIF</td>
<td>Should support for ONVIF 2.0 allows for standards based interoperability</td>
</tr>
<tr>
<td>Motion Detection</td>
<td>Five-window video motion detection</td>
</tr>
<tr>
<td>Auto Tracking</td>
<td>Auto-tracking on moving object</td>
</tr>
<tr>
<td>Casing</td>
<td>IP66, IK10, NEMA 4X</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>$-40$ to $50^\circ$C</td>
</tr>
<tr>
<td>Certifications Safety and EMC-Requirements</td>
<td>CE, FCC Class A, NEMA4X, UL</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 keep the object in its field of view.</td>
</tr>
<tr>
<td>Connectors</td>
<td>RJ-45 cable connector for Network/PoE connection Audio input &amp; Audio output</td>
</tr>
<tr>
<td>Image Settings</td>
<td>Time stamp, text overlay, flip &amp; mirror; Configurable brightness, contrast, saturation, sharpness, white balance, exposure control, gain, backlight compensation, privacy masks ; Scheduled profile settings, EIS, 3DNR, defog</td>
</tr>
<tr>
<td>Alarm triggers</td>
<td>Manual trigger, system boot, recording notification, motion detection</td>
</tr>
</tbody>
</table>

### 3.1.3. ONVIF Video Management Software

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>Characteristics and Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General Video Management System requirement</td>
</tr>
<tr>
<td>1</td>
<td>The Video Surveillance System is intended to effectively monitor all the critical operational areas i.e. Perimeter wall, corridors and entrance gate etc. The Surveillance System shall provide an on-line display of video images on monitors at security control room.</td>
</tr>
<tr>
<td>S.NO.</td>
<td>Characteristics and Description</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>2</td>
<td>It should facilitate viewing of live and recorded images and controlling of all cameras by authorized users.</td>
</tr>
<tr>
<td>3</td>
<td>VMS shall include, as a minimum, the following features/ functions/ specifications;</td>
</tr>
<tr>
<td>4</td>
<td>The surveillance system shall provide a scalable and reliable platform to enable customized, network-based surveillance applications.</td>
</tr>
<tr>
<td>5</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>6</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>7</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>8</td>
<td>VMS system should highly scalable and shall be expandable up to 10,000 cameras.</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>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 supports Bulk 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>
<tr>
<td></td>
<td>The VMS should support redundancy in 1:1, N:1 and 1:N forms.</td>
</tr>
<tr>
<td>S.NO.</td>
<td>Characteristics and Description</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td></td>
<td>The Redundancy feature should allow to failover critical cameras from various servers into the failover server. The redundancy feature should be automatic failover and automatic failback without any manual intervention. The failover should happen for VMS, Analytics and I/O devices.</td>
</tr>
<tr>
<td></td>
<td><strong>VMS Server Management Console</strong></td>
</tr>
<tr>
<td></td>
<td>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. 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. VMS Server Management systems should support network time protocol (NTP) on server, which automatically sets the server time and date.</td>
</tr>
<tr>
<td></td>
<td><strong>VMS Operations &amp; Management Console</strong></td>
</tr>
<tr>
<td></td>
<td>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. VSM operation and management system should support the following feature; Manage physical devices - Add, configure and monitor the cameras and servers that provide live and recorded video. Manage server services - Configure, enable or disable server services, such as the recording servers that manage video playback and recording. 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. Define recording and event policies - Create recording schedules, define event-triggered actions, configure motion detection, and other features. Monitor system and device health - View a summary of system health for all devices, or device status, alerts and events.</td>
</tr>
<tr>
<td></td>
<td><strong>VMS Monitoring Console</strong></td>
</tr>
<tr>
<td></td>
<td>VMS monitoring Console application should allow VMS System users to monitor live and recorded video. VMS monitoring Console should support below viewing tools &amp; features;</td>
</tr>
<tr>
<td></td>
<td><strong>I. Desktop Monitoring application</strong></td>
</tr>
<tr>
<td></td>
<td>Shall support for viewing the monitoring at minimum 5 different places in the complex.</td>
</tr>
</tbody>
</table>
### S.NO. | Characteristics and Description
--- | ---

1. &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;shall support simultaneous viewing of up to suitable No. of cameras as per workspace/work station configuration.  
2. &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;Create Video Matrix windows for display in separate monitors.  
3. &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;Create unattended workstations.  
4. &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;View and manage alerts.  
5. &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;View cameras, video, and alerts based on a graphical map

### II. Web-based configuration and monitoring tool

6. &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;Allows simultaneous viewing of multiple video panes, View up to suitable No. of cameras with the 64-bit version of Internet Explorer.  
7. &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;Configure the camera, streams and recording schedules

### III. Web Based Server Console

8. &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;Should provide basic viewing features for a single stream (Stream A) from a single camera  

#### Analytic features: Shall support following Analytics Feature

9. &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;Clip Management—Use Clip Management to view, download and delete MP4 clips. that are stored on the server.  
10. &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;Motion detection and Analysis—Use Motion Analysis to view a summary of motion events for recorded video.  
11. &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;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.  
12. &nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;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.

- Activity- Detects moving objects within an area that is configured in the camera view  
- Line Crossing—Detects moving objects that cross a line that is configured in the camera view  
- Object Taken—Detects a marked object in the camera view being removed from its location  
- Zone Intrusion—Detects objects that enter an area that is configured in the camera view  
- 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.NO.</th>
<th>Characteristics and Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VMS software &amp; recording &amp; Management server should be from same OEM</td>
</tr>
<tr>
<td></td>
<td>VMS software, Analytics software &amp; recording &amp; Management server should be from same OEM. Also ANPR and facial detection from the same OEM</td>
</tr>
<tr>
<td></td>
<td>The VMS should be able to integrate with the edge analytics of the cameras.</td>
</tr>
</tbody>
</table>

### 3.1.4. Specifications of Central Core Server for Surveillance Operation & Management Application at DC.

<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>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>
<tr>
<td>10</td>
<td>Operation &amp; Management Licenses</td>
<td>Server should be supplied with VSM licenses for Management &amp; Operation license, which should be able manage atleast 15 recording servers &amp; 300 camera's</td>
</tr>
</tbody>
</table>

### 3.1.5. 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>Sr. No.</td>
<td>Item</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</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>

### 3.1.6. Storage Server

- Storage Server shall be capable to record data up to 30 days.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Capacity</td>
<td>The capacity should be 240 TB RAW or 200 TB Usable with RAID-6 (10+2) Configuration for Storage using 10 TB of each disk Capacity for video content.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The offered disk storage should be of 56 Disk Enclosure and capable to add min. three more Disk expansion module to increase the Capacity offered by adding disk and controller units or min. 226 disk in the system.</td>
</tr>
<tr>
<td>2</td>
<td>Fault Tolerant</td>
<td>The Disk controller offered should have minimum support for RAID 0,1,3,5,6,10, and 50.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The cache of each controller should not be less than 6GB per controller and shall have backup mechanism to protect the data on cache in case of power failure.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The Disk controller or expansion units should have redundant power supplies and to be connected to alternative power sources such as UPS.</td>
</tr>
<tr>
<td>3</td>
<td>Supported Disk Types.</td>
<td>The offered disk controller shall support for SSD, SAS and NL-SAS disk types of maximum capacity available.</td>
</tr>
<tr>
<td>4</td>
<td>Host Interface</td>
<td>The offered storage shall support for minimum 4 no. of 8 Gbps or more Fiber channel host interfaces or iSCSI ports for connectivity.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The host interface module shall be inter-changeable to switch to 10GigE or iSCSI interface if required.</td>
</tr>
<tr>
<td>5</td>
<td>Performance</td>
<td>The offered storage should be configurable to provide minimum 90% Write and 10% read workload. It should support Read Performance up to 3.2 Gbps &amp; Write Performance up to 2.4 Gbps</td>
</tr>
<tr>
<td>6</td>
<td>Regulatory Compliance</td>
<td>The offered Disk Platform should be Network Equipment Building System-compliant Or MIL-STD-810F/G</td>
</tr>
<tr>
<td>7</td>
<td>Protocol &amp; Standards support</td>
<td>SNMP, SSL, SSH, SMTP, SMI-S Provider, HTTP(s) IP (RFC, 984, 1092) SCSI-2 and SCSI-3 OpenStack Cinder compatible IP (RFC, 894, 1092), SCSI-2 and SCSI-3</td>
</tr>
</tbody>
</table>
8. **Shock & Vibrations**

- Shock, Operational - 3Gs for 10ms, half sine
- Shock, Non-Operational - 10Gs for 11ms, half sine
- Vibration, Operation - 5Hz to 500Hz, 0.21 Grms flat spectrum
- Vibration, Non-Operational - 3-365-3Hz, 1.22 Grms, Z-axis, 0.85 Grms, X- & Y-axis shaped spectrum

9. **Others**

- Virtual Disks per System - 32
- Volumes per System - 1024
- Super Capacitor Cache Backup - Yes
- Mirrored Cache - Yes

### 3.1.7. Network Video Recorder:

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Maximum IP Cameras</td>
<td>128/64/32/16 channel</td>
</tr>
<tr>
<td>2</td>
<td>Pre-Loaded VMS Software</td>
<td>Professional (standard), Enterprise (optional)</td>
</tr>
<tr>
<td>3</td>
<td>Typical Video Storage Rate (Mbps)</td>
<td>350 Mbps (Windows) 550 Mbps (Linux)</td>
</tr>
<tr>
<td>4</td>
<td>Local Client Display Rate (FPS)</td>
<td>Windows – 700 FPS (HD) Linux – 900 FPS (HD)</td>
</tr>
<tr>
<td>5</td>
<td>Maximum Storage</td>
<td>80 TB (RAID 5 Optional)</td>
</tr>
<tr>
<td>6</td>
<td>Monitor Output</td>
<td>1 DVI-I + HDMI + 1 Display Port, max 2 simultaneous monitors</td>
</tr>
<tr>
<td>7</td>
<td>Operating System</td>
<td>Windows 10, Windows 2012 R2 (Optional), Ubuntu Linux 16.04</td>
</tr>
<tr>
<td>8</td>
<td>CPU</td>
<td>Gen 4 Intel Core i3, Intel Core i5 or i7 (optional)</td>
</tr>
<tr>
<td>9</td>
<td>RAM</td>
<td>4 GB, 8 GB, 12 GB (optional)</td>
</tr>
<tr>
<td>10</td>
<td>USB</td>
<td>6 x USB 2.0, 2 x USB 3.0</td>
</tr>
<tr>
<td>11</td>
<td>Operating Temperature</td>
<td>40° - 95° F 4.5° - 35° C</td>
</tr>
<tr>
<td>12</td>
<td>Regulatory</td>
<td>CE, FCC, cULus, UL Listed</td>
</tr>
</tbody>
</table>

### 3.1.8. 40”/55” 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>40”/55” (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>350 cd/m2</td>
</tr>
<tr>
<td>Sr.No</td>
<td>Parameter</td>
<td>Specification</td>
</tr>
<tr>
<td>-------</td>
<td>------------------------------------</td>
<td>--------------------------------</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 1 (SERIAL IN/Out)</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>Power Consumption:</td>
<td>Less than 250 W</td>
</tr>
<tr>
<td>24</td>
<td>Mechanical:</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Temperature:</td>
<td>32°F to 104°F (0 to 40 degrees C)</td>
</tr>
<tr>
<td>26</td>
<td>Humidity(Non condensation):</td>
<td>20% to 80% (Non condensation)</td>
</tr>
</tbody>
</table>

4. ACCESS CONTROL SYSTEM & BOOM BARRIER

4.1. ACCESS CONTROL SOFTWARE:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Features of the Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Access Management Software shall use industry standard hardware with Windows Server (latest version) operating systems.</td>
</tr>
<tr>
<td>2</td>
<td>The Access Management Software shall provide full support for Virtualization technologies like VMware ESX and Windows HyperV.</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Features of the Software</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>3</td>
<td>The Access Management Software shall provide full support for leading open standards: BACnet, LonMark, OPC and Modbus. Enterprise Web Services shall also be available to extend Access Management Software with powerful value added applications.</td>
</tr>
<tr>
<td>4</td>
<td>The Access Management Software shall be designed and developed to International Standards ISO 9001 for quality.</td>
</tr>
<tr>
<td>5</td>
<td>The Access Management Software must be UL Listed to Standards: UL864 (Accessory and Panels Fire, Smoke Control, UL1017 and UL1076 (Security Systems), UL1610 (Central Station) and UL294 (Access Control)</td>
</tr>
<tr>
<td>6</td>
<td>The Access Management Software shall support superior fault tolerance, Access Management Software shall be configured for high-availability architecture to operate in a redundant hot standby configuration. To achieve this level of reliability, there shall be two servers: one is dedicated as the primary server and the other acts as the standby server. If the primary server encounters a problem, the standby server automatically assumes control and reconnects controllers and clients within 10 seconds without loss of data minimized to a this period.</td>
</tr>
<tr>
<td>7</td>
<td>The Access Management Software redundancy solution shall not replicate all operating system software between the two servers, ensuring that malware or driver and Operating System problems are NOT replicated to the backup system.</td>
</tr>
<tr>
<td>8</td>
<td>The Access Management Software shall support servers to be connected together in a Distributed System Architecture, allowing very large or geographically distributed sites to be operated as a single system.</td>
</tr>
<tr>
<td>9</td>
<td>The Access Management Software shall support upto 80 concurrent operator workstation connections on a single server. Client software can be loaded on unlimited number of PC’s allowing a limitless number of users to access these connections on a first-come, first-served basis.</td>
</tr>
<tr>
<td>10</td>
<td>The Access Management Software shall support station based resident clients, web browser clients and clients on mobile and tablet devices.</td>
</tr>
<tr>
<td>11</td>
<td>The Access Management Software shall have Web-based user interface providing operators or facility engineers easy access and puts the user in control of every situation.</td>
</tr>
<tr>
<td>12</td>
<td>The Access Management Software shall have Web-style menus, tool bars, and icons allowing intuitive navigation and fast access to important information</td>
</tr>
<tr>
<td>13</td>
<td>The Access Management Software shall also have an unlimited number of custom (facility specific) displays created to meet the needs of the specific facility. The Access Management Software shall also have a set of standard displays for configuration, and navigation around the Access Management Software system.</td>
</tr>
<tr>
<td>14</td>
<td>The operator interface shall be interactive and totally graphics and/or icon based. The operator interface shall allow a user to perform the following tasks:</td>
</tr>
<tr>
<td>a</td>
<td>Monitor and Control field equipment</td>
</tr>
<tr>
<td>b</td>
<td>Acknowledge alarms on a priority basis</td>
</tr>
<tr>
<td>c</td>
<td>Display point status and history information</td>
</tr>
<tr>
<td>d</td>
<td>Display information about cardholders</td>
</tr>
<tr>
<td>e</td>
<td>Define and alter time schedules</td>
</tr>
<tr>
<td>f</td>
<td>Initiate printing of reports</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Features of the Software</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>g</td>
<td>View, archive and retrieve event logs</td>
</tr>
<tr>
<td>h</td>
<td>Monitor data communications channels</td>
</tr>
<tr>
<td>i</td>
<td>Configure system parameters</td>
</tr>
<tr>
<td>j</td>
<td>Display information from Internet and Intranet sites</td>
</tr>
<tr>
<td>15</td>
<td>The Access Management Software shall have a utility to create Custom HTML displays. A typical custom display shall include a static background, and dynamic objects that indicate the status and alarm condition of relevant devices. Pop up face plates showing more information about a device can also be used. Also, controls, such as buttons, can be added so that users can execute tasks, call up other displays and generate reports. The HTML format of custom displays shall provide interoperability with other Web technologies and Web authoring tools.</td>
</tr>
<tr>
<td>16</td>
<td>The Access Management Software shall support integration of Video into custom displays and control of PTZ cameras using display controls.</td>
</tr>
<tr>
<td>17</td>
<td>The Access Management Software shall support integration of existing Intranet or Internet pages into custom displays, enabling Access Management Software data to be matched with external information such as weather or key company policies and procedures.</td>
</tr>
<tr>
<td>18</td>
<td>The Access Management Software shall support integration of data into intranet, providing building occupants with live data regarding their comfort or other facility information.</td>
</tr>
<tr>
<td>19</td>
<td>The Access Management Software shall have browser independent, optimized user interface for Smart Phones. The mobile interface shall provide anywhere and any time supervisory monitoring and control.</td>
</tr>
<tr>
<td>20</td>
<td>The Access Management Software shall support six different levels of operator security. It shall be possible to restrict and control what activity operators can perform by giving them different security levels.</td>
</tr>
<tr>
<td>21</td>
<td>The Access Management Software shall have &quot;control levels&quot; to limit manual control of specified critical points. Only operators with appropriate control levels can issue commands to these points.</td>
</tr>
<tr>
<td>22</td>
<td>The Access Management Software shall support HTTPS connections (secure web connections) and also requires use of certificates to authenticate users and applications to operate and control the system remotely over public networks.</td>
</tr>
<tr>
<td>23</td>
<td>The Access Management Software shall have an event-based rules engine to simplify the automation of routine integration tasks and reduce the need to write complex, time-consuming scripts.</td>
</tr>
<tr>
<td>24</td>
<td>The Automation Rules shall support integration of Video, Access, Fire and BMS points with each other and calling of plant display on a specific station.</td>
</tr>
<tr>
<td>25</td>
<td>The Access Management Software shall be able to group points based on alarm inputs, outputs, controller, area, doors or elevators etc. An operator can then control a group or monitor it as one entity. There shall be a summary display showing information about the groups, including the number of points in a group and the number of points in each state.</td>
</tr>
<tr>
<td>26</td>
<td>The Access Management Software shall support logical partitioning of facility into separate locations. Each location shall have a logical set of points, cardholders, reports and displays. Each operator shall be allowed to view, monitor, and control only those points or cardholders within their designated Location.</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Features of the Software</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>27</td>
<td>The Access Management Software shall have Alarm Summary feature and the operator shall be able to view a display showing all currently active alarms on a single click.</td>
</tr>
<tr>
<td>28</td>
<td>The alarm messages shall be color-coded to show priorities. From the Alarm Summary display, the operator shall be able to acknowledge alarms and access an associated display defined for each point.</td>
</tr>
<tr>
<td>29</td>
<td>The operator shall be able to sort alarms or filter only for certain characteristics.</td>
</tr>
<tr>
<td>30</td>
<td>The operator shall be able to add comments to alarms or print an appropriate alarm list.</td>
</tr>
<tr>
<td>31</td>
<td>The Access Management Software shall be able to announce the alarms as audible tone based on a customizable *.wav file on each station.</td>
</tr>
<tr>
<td>32</td>
<td>Alarms shall announce at Stations even if no user is currently signed on. Even if Station is minimized, the audible tone sounds and the Station icon flashes to indicate that there is an alarm.</td>
</tr>
<tr>
<td>33</td>
<td>The Access Management Software shall have a dedicated alarm line appearing on all displays and showing the most recent, highest priority, unacknowledged alarm in the system.</td>
</tr>
<tr>
<td>34</td>
<td>The Access Management Software shall have sophisticated alarm prioritization by assigning different priority levels: Journal, Low, High and Urgent. Each alarm priority level shall support up to 15 sub-priorities within it.</td>
</tr>
<tr>
<td>35</td>
<td>It shall be possible to automatically elevate an alarm to the next highest priority level or generate an additional alarm if an operator does not acknowledge an alarm within a certain time, ensuring alarms are always handled promptly.</td>
</tr>
<tr>
<td>36</td>
<td>The Access Management Software shall automatically keep count of how many times this same alarm has recurred, which allows the Alarm Summary Display to remain less cluttered as common or nuisance alarms are aggregated into a single alarm message.</td>
</tr>
<tr>
<td>37</td>
<td>The Access Management Software shall automatically calculates alarm metrics to quickly tell the number of urgent, high and low priority alarms in each location. These alarm metrics can be historized and trended, and reported on at shift boundaries or other times.</td>
</tr>
<tr>
<td>38</td>
<td>The Access Management Software shall have Advanced Alarm Management feature to assist operators. When an operator acknowledges an alarm, they proceed to an alarm instruction page which details appropriate alarm handling procedures. After following these procedures, the operator can enter a response that indicates the actions taken to correct the situation, or can choose from a pre-configured list of responses. Operator responses are logged to an event file for subsequent analysis.</td>
</tr>
<tr>
<td>39</td>
<td>The Access Management Software shall allow alarms to be routed to mobile phones and emails through GPS/GPRS modem. It shall also support remotely acknowledge the alarm via an SMS. It shall be possible to nominate a range of points and the alarm priority for recipients of SMS and emails.</td>
</tr>
<tr>
<td>40</td>
<td>The Access Management Software shall store event data in an online buffer. It shall be possible to store as many events as necessary—subject only to disk space on the server. When the on-line buffer becomes full, event data shall be transferred to an archived buffer and notifies the operator to save the file to external media.</td>
</tr>
<tr>
<td>41</td>
<td>The Access Management Software shall provide comprehensive reporting facilities including a range of standard reports, the ability to create custom reports, the ability to export and import information and the ability to use other standard reporting systems.</td>
</tr>
<tr>
<td>42</td>
<td>The Access Management Software shall be able to generate all standard reports on...</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Features of the Software</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>43</td>
<td>It shall be possible to generate the report periodically, such as once per day, or may be initiated by an event.</td>
</tr>
<tr>
<td>44</td>
<td>The Access Management Software shall provide ODBC (open database connectivity) access to its database from any ODBC - compliant tool.</td>
</tr>
<tr>
<td>45</td>
<td>The Access Management Software shall utilize SQL Server Reporting Services (SSRS) to deliver powerful custom reports which can be configured and tailored via Visual Studio 2008, or the simple custom report tools delivered within SSRS.</td>
</tr>
<tr>
<td>46</td>
<td>Deadman Timer: If there is no operator activity for a defined period, The Access Management Software system shall automatically sign off the operator. A warning message shall notify the operator before this happens. If that operator does not sign onto the system again, Access Management Software shall automatically controls an output to alert help.</td>
</tr>
<tr>
<td>47</td>
<td>The Access Management Software shall be able to track a guard through defined tours of a building or facility using a Guard Tour. Guard Tours can be programmed using any logical combination of card readers and input points as tour checkpoints. At each point along the tour, it shall be possible to switch cameras, disable alarms, or toggle lights.</td>
</tr>
<tr>
<td>48</td>
<td>The Access Management Software shall support use of Enterprise Web Services (EWS) to allow open interface with custom apps, queries, web pages or business systems.</td>
</tr>
<tr>
<td>49</td>
<td>The Access Management Software shall have seamless integration with Video Surveillance System that allows live viewing and digital recording of video from network connected cameras through Access Management Software user interface.</td>
</tr>
<tr>
<td>50</td>
<td>The Access Management Software shall directly interface with Access Controllers installed in or across the buildings connected over LAN. It shall also provide the comprehensive control and monitoring of all access controlled doors and cardholders inside the premises.</td>
</tr>
<tr>
<td>51</td>
<td>The Access Management Software shall have easy-to-use card holder management system supporting minimum 100K cardholders.</td>
</tr>
<tr>
<td>52</td>
<td>The Access Management Software shall have 94 pre-configured user fields for each card holder. All of these user fields shall be editable to match the requirement. In addition, it shall be possible to add or remove user fields to customize card holder database structure.</td>
</tr>
<tr>
<td>53</td>
<td>The layout of card holder information on displays in Access Management Software shall be editable to reflect a set of user fields and meet the design preferences.</td>
</tr>
<tr>
<td>54</td>
<td>The Access Management Software shall be able to assign multiple cards to each card holder to allow a flexible approach to dealing with situations such as lost cards, forgotten cards or the need to issue two cards to a card holder.</td>
</tr>
<tr>
<td>55</td>
<td>It shall be easily possible to add cards and cardholders to the system.</td>
</tr>
<tr>
<td>56</td>
<td>It shall be possible for cards assigned to cardholders or remain as “unissued” cards.</td>
</tr>
<tr>
<td>57</td>
<td>It shall be possible to simultaneously edit Multiple cardholders at by using the “multi-select” capability.</td>
</tr>
<tr>
<td>58</td>
<td>The Access Management Software shall be able to create a customized Card holder Templates for each group of cardholders.</td>
</tr>
<tr>
<td>59</td>
<td>The Access Management Software shall allow a search for cardholders and cards by entering the first couple of letters of the card holder’s name or any searchable field.</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Features of the Software</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>60</td>
<td>The Access Management Software shall be able to generate photo identification badges displaying a card holder’s image and/or signature.</td>
</tr>
<tr>
<td>61</td>
<td>The Access Management Software shall support TWAIN standard for interfacing to image capture device and WinTab standard for interfacing with Signature Pads.</td>
</tr>
<tr>
<td>62</td>
<td>The application to design the Photo Identification Card shall be the part of Access Management Software package.</td>
</tr>
<tr>
<td>63</td>
<td>The Access Management Software shall support standard Windows supported card printers to generate Photo ID cards.</td>
</tr>
<tr>
<td>64</td>
<td>The Access Management Software shall have the ability to add pictures, logos, magnetic strip encoding and bar codes to photo identification cards. It shall be possible to use chroma key or image ghosting for extra security.</td>
</tr>
<tr>
<td>65</td>
<td>The Access Management Software shall support biometric devices such as fingerprint, palm vein, retina and face readers that have an industry standard Wiegand output to connect to an access control panel.</td>
</tr>
<tr>
<td>66</td>
<td>The Access Management Software shall support updation of card holder data from external systems such as the People Soft Human Resources database or SAP Enterprise Management System.</td>
</tr>
<tr>
<td>67</td>
<td>It shall be possible to send Time and Attendance data and card holder details from Access Management Software back to HR systems. This information shall be used to calculate how long particular cardholders have been on site for occupational health and safety purposes or for payroll purposes.</td>
</tr>
<tr>
<td>68</td>
<td>The Access Management Software shall support a minimum of 256 time periods. Time periods shall be used to specify the times when cardholders have access to certain zones.</td>
</tr>
<tr>
<td>69</td>
<td>The Access Management Software shall support up to 1024 zones to control access to the facility. Each zone shall consist of the following: * Description * Organization * Up to 128 doors</td>
</tr>
<tr>
<td>70</td>
<td>The Access Management Software shall support up to 1024 access permissions. Each access permission shall consist of the following: * Description * Organization or Company / Department * Up to 256 zone and time period pairs</td>
</tr>
<tr>
<td>71</td>
<td>It shall be possible to assign up to 64 access rights/level to each card holder.</td>
</tr>
<tr>
<td>72</td>
<td>The Access Management Software shall have Path Control feature to force a card holder to follow a fixed path to reach a destination.</td>
</tr>
<tr>
<td>73</td>
<td>The Access Management Software shall have Escort feature to allow a transit if a card holder is escorted by another user with “escort” rights.</td>
</tr>
<tr>
<td>74</td>
<td>The Access Management Software shall have Zone Control feature to limit maximum number of people authorized to be present simultaneously in the zone and/or Time duration for each person to stay in the zone.</td>
</tr>
<tr>
<td>75</td>
<td>The Access Management Software shall have Trace feature to send an alarm to the host every time a certain card holder uses a door.</td>
</tr>
</tbody>
</table>
### Features of the Software

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Feature Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>76</td>
<td>The Access Management Software shall have Global Anti pass back feature and shall be supported across the system without having Access Management Software system running, this shall be possible using peer to peer communications between the Access Controllers.</td>
</tr>
<tr>
<td>77</td>
<td>The Access Management Software shall have Use before Expiry feature to define the number of times that a card holder may use their cards. This number shall be decremented every time the card holder uses their card at a reader until the number is 0, when the card holder shall no longer have access.</td>
</tr>
</tbody>
</table>
| 78      | The Access Management Software shall have an integrated Time & Attendance Module. The T&A module must have following features.  
1. Calculating Attendance data based on the first in and last out transaction  
2. Provides Shift Management  
3. Identify attendance exceptions such as Single Swipe and absenteeism.  
4. Track departmental Attendance.  
6. Comprehensive Management Information, reporting and historical data enquiry management  
7. Attendance Regularization in case of- Out Duty, Leave and Mismatch |

### 4.2. ACCESS DOOR CONTROLLER:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Technical Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Access Controller</strong></td>
</tr>
<tr>
<td>1</td>
<td>The controller shall be a 32 bit microprocessor with Linux OS.</td>
</tr>
<tr>
<td>2</td>
<td>The controller shall have 128 MB DDR SRAM and 64 MB Flash memory.</td>
</tr>
<tr>
<td>3</td>
<td>Support minimum 16 doors with a readers for entry and exit.</td>
</tr>
<tr>
<td>4</td>
<td>Support minimum 16 standard Weigand Interface on LONbus.</td>
</tr>
<tr>
<td>5</td>
<td>Support minimum 64 I/Os with expandable 4 DI/DO modules on LONbus.</td>
</tr>
<tr>
<td>6</td>
<td>Controller level redundancy with Hot Redundant Controller failover without manual intervention.</td>
</tr>
<tr>
<td>7</td>
<td>The access controller shall support minimum Card Holder Memory: 1,00,000 card holders, expandable upto 2,50,000 card holders</td>
</tr>
<tr>
<td>8</td>
<td>The controller shall support minimum 100000 transaction buffer and 10000 event buffer.</td>
</tr>
<tr>
<td>9</td>
<td>The controller shall have autonomous clock/calender with geographic time zone support and daylight saving.</td>
</tr>
<tr>
<td>10</td>
<td>The controller shall have on-board 10/100MB Ethernet connection for TCP/IP connectivity.</td>
</tr>
<tr>
<td>11</td>
<td>Controller shall have built-in web server and support web access.</td>
</tr>
<tr>
<td>12</td>
<td>Shall perform in a peer to peer network with other controllers</td>
</tr>
<tr>
<td>13</td>
<td>Controller shall have IPSEC with 3DES encryption on LAN communication.</td>
</tr>
<tr>
<td>14</td>
<td>Controller shall have Tamper protection feature.</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Technical Specifications</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>15</td>
<td>Controller shall have battery backup with full functionality for 90 minutes in case of power failure and signalling of battery recharge on the controller itself.</td>
</tr>
<tr>
<td>16</td>
<td>Wall mountable with IP55 protection</td>
</tr>
<tr>
<td>17</td>
<td>Input Power: 230 Volts, AC power supply (single phase).</td>
</tr>
<tr>
<td>18</td>
<td>Certification: CE, UL, FCC</td>
</tr>
<tr>
<td>19</td>
<td>Operating Temp.: -10°C to +40°C</td>
</tr>
<tr>
<td>20</td>
<td>Operating Humidity.: up to 90% non condensing Humidity</td>
</tr>
</tbody>
</table>

### 4.3. BIOMETRIC READER:-

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Parameters</th>
<th>Technical Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Finger print Readers</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Fingerprint Sensor</td>
<td>500 dpi Optical Sensor</td>
</tr>
<tr>
<td>2</td>
<td>Fingerprint Capacity</td>
<td>10K templates (5K users with 2 templates per user)</td>
</tr>
<tr>
<td>3</td>
<td>Log Capacity</td>
<td>50K events</td>
</tr>
<tr>
<td>4</td>
<td>Identification Speed</td>
<td>2000 matches per second</td>
</tr>
<tr>
<td>5</td>
<td>Card Reader</td>
<td>13.56MHz Mifare</td>
</tr>
<tr>
<td>6</td>
<td>Operation Mode</td>
<td>Fingerprint, Fingerprint+ Pin/Card</td>
</tr>
<tr>
<td>7</td>
<td>Network Interface</td>
<td>TCP/IP, RS485</td>
</tr>
<tr>
<td>8</td>
<td>Reader output</td>
<td>Wiegand</td>
</tr>
<tr>
<td>9</td>
<td>Display</td>
<td>128x64 graphic monochrome LCD, Multi - color LED</td>
</tr>
<tr>
<td>10</td>
<td>Keypad</td>
<td>3x4 keypad, 3 navigation keys</td>
</tr>
<tr>
<td>11</td>
<td>Audio</td>
<td>Multi tone Buzzer</td>
</tr>
<tr>
<td>12</td>
<td>Power Supply</td>
<td>12 VDC</td>
</tr>
<tr>
<td>13</td>
<td>Protection Class</td>
<td>IP66</td>
</tr>
<tr>
<td>14</td>
<td>Operating Temp</td>
<td>-20°C to +50°C</td>
</tr>
<tr>
<td>15</td>
<td>Certifications</td>
<td>CE</td>
</tr>
</tbody>
</table>

### 4.4. CARD READER:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Technical Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Smart Card Reader</strong></td>
</tr>
<tr>
<td>1</td>
<td>Read Range- upto 5cm</td>
</tr>
<tr>
<td>2</td>
<td>Mounting- Mullion</td>
</tr>
<tr>
<td>3</td>
<td>Operation Frequency- 13.56MHz</td>
</tr>
<tr>
<td>4</td>
<td>Reader Output- Wiegand</td>
</tr>
</tbody>
</table>
4.5. Boom Barrier:

All Entries and exits should be installed with motorized Boom Barriers for security checking of the vehicles entry in the complex. The complex shall have boom barrier in the parking also. The security guard at each Entry & Exit Gate shall have the access/ control of the boom barrier. The push button will be installed in the security guard room at Entry & Exits. The length of the boom Barrier shall be according to the road width & as per the requirement.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>Outdoor</td>
</tr>
<tr>
<td>Drive</td>
<td>Block able Continuous Torque Motor</td>
</tr>
<tr>
<td>Version</td>
<td>Left handed (changeable to Right Hand)</td>
</tr>
<tr>
<td>Logic Control</td>
<td>Included</td>
</tr>
<tr>
<td>Intelligence</td>
<td>The use of Block able Torque Motor Drive with continues torque Output and the microprocessor based controller eliminates the need for friction clutches to ensure maintenance free operation. The barrier may be installed at any position.</td>
</tr>
<tr>
<td>Power Supply</td>
<td>230 +/-10% VAC, 50Hz.</td>
</tr>
<tr>
<td>Colour</td>
<td>Different and distinct colour pattern as decided by owner. The paint used will be anti-corrosive and luminous for night and bad weather.</td>
</tr>
<tr>
<td>Boom Specifications</td>
<td>straight or articulated -extruded aluminium alloy. Boom with octagonal profile (straight and articulated 100mm x 55mm x 1.6mm.</td>
</tr>
<tr>
<td>Housing Dimension</td>
<td>W300mm, D 350mm, H1040mm.</td>
</tr>
<tr>
<td>Protection</td>
<td>All Housing and internal parts will be rust &amp; corrosion free metals or alloys of high strength with suitable Epoxy coating as applicable.</td>
</tr>
<tr>
<td>Opening</td>
<td>1.4 seconds for 3 meters and 4 meters long Boom Barrier &amp; 2-3 seconds for 5 meters and 6 meters long boom Barrier.</td>
</tr>
<tr>
<td>Closing Time</td>
<td>Should be 1.4 to 3.6 Sec approx.</td>
</tr>
<tr>
<td>Power-Off</td>
<td>Manual Opening Possible</td>
</tr>
<tr>
<td>Operation</td>
<td>Push button type for electro-mechanical operation to open and close the Boom Barrier</td>
</tr>
<tr>
<td>Duty Cycle</td>
<td>100%</td>
</tr>
</tbody>
</table>
4.6. SPECIFICATION FOR CABLES

i) 8 Conductor, 18-24 AWG, Overall Shielded, PVC for Card Readers

| Description | Shielded multi conductor control cable |
| Conductors | 18/22 AWG 7/32 Strand Tinned Copper, 6 conductors |
| Insulation | Colour coded PVC 0.010" |
| Colour Code | Black, white, red, green, blue, brown |
| Shielding | 100% aluminium mylar foil shield overall with a 24 AWG 7/32 strand tinned copper drain wire. |
| Jacket | Gray flame retardant PVC 0.032" |
| Nominal OD | 0.205" |
| Capacitance | 33 pF/Ft between conductors |
| Ratings | Manufactured in accordance with UL subject 13, type CM Passed UL VW-1 Flame Test UL CM approved |

ii) 2 Pair, 18 AWG, Individually Shielded, Poly propylene Insulated Signal Cable for Intelligent Controller Communication.

| Description | 2 pair individually shielded cable |
| Conductors | 18 AWG 7/30 Strand tinned copper, twisted into 2 pairs |
| Insulation | Colour coded polypropylene, 0.008" |
| Colour Code | Black with red, Green with white |
| Shielding | Each pair individually shielded with 100% aluminium mylar foiled shield plus 22 AWG 7/30 strand tinned copper drain wire. |
| Jacket | Gray flame retardant PVC |
| Nominal OD | 0.170" |
| Capacitance | 35 pF/Ft |
| Voltage | UL rated 300 Volts |
| Ratings | Manufactured in accordance with UL subject 13, type CM Passed UL VW-1 Flame Test UL CM approved |

iii) 2 Pair, 20 AWG, Shielded, Multi-pair, Signal Cable for Electrical Bolt Release.

| Description | 3 pair over-al l shielded cable |
| Conductors | 20 AWG 7/28 Strand tinned copper, twisted into 3 pairs |
| Insulation | Colour coded polypropylene, 0.010" |
| Colour Code | Black with red, Black with white, Black with Green |
| Shielding | 100% aluminium mylar foiled shield overall with 22 AWG 7/30 strand tinned copper drain wire. |
| Jacket | Gray flame retardant PVC 0.020" |
| Nominal OD | 0.251" |
5. NURSE CALL SYSTEM

It is proposed that Hospital Building shall be provided with a “IP based Nurse Call System”. The System shall be approved in accordance with VDE guidelines/ international guidelines. It is proposed that Nurse Call System shall be provided for all Beds with Speech facility & without Speech facility. Nurse Call System for Single Bed/ Double Bed/ Deluxe Suite/ Super Deluxe Suite Rooms, Critical Areas etc. shall be equipped with Speech Facility as directed by Engineer-In-Charge. Likewise, Nurse Call System for the Beds in General Wards/Rooms, Toilets etc. shall be without Speech Facility as directed by Engineer-In-Charge.

The “System” shall be designed in such a way that the most effective communication between Patient, Nursing Staff, Doctor & management staff can be provided in the least possible time.

Nurse Call System shall be provided in the wards/ rooms where patient will stay. Some areas mentioned below but not limited to, are as follows:

a) IPD Wards
b) IPD Rooms (Single Bed/ Double Bed/ Deluxe Suite/ Super Deluxe Suite)
c) Recovery Rooms
d) MICU/ ICU/ HDU
e) Emergency Rooms
f) Pre/ Post Operation & Cath,
g) Ward (Chemo, Multipurpose, observation, Triage, Day Care) etc.
h) Any other area as required.

The Nurse Call System with voice facility shall be provided for Single Bed/ Double Bed/ Deluxe Suite/ Super Deluxe Suite rooms. The other wards shall be provided with Nurse Call System without voice facility.

5.1.1. Main Controllers:

Controller shall be IP based & all the nurse station/ patient handset & other equipment shall be connected to main controller through CAT6a cable. Main controllers shall be networkable with other controllers through IP/ CAT6a. Fault in one controller shall not have the effect on working of another controller. Each controller shall be able to work independently in case there is problem in network.

5.1.2. Nurse Station:

Nurse station shall have large LC display capable of showing multiple patient call at a time with bed/ ward no., type of call, date & time. There shall be scroll down feature as well in case no. of patient call increase at a given time i.e. there shall not be any chance of missing any patient call. There shall be feature to priorities patient call depending upon patient condition, type of call & location (Bed or WC). Nurse station shall have voice facility. It shall be user friendly & have good aesthetic looks. All Nurse Stations shall be networked with other nurse station with facility of call forwarding/ diverting/ escalating calls in between nurse station. Nurse station shall be programmable so that emergency calls shall always be on top priority.
There shall be option of displaying patient call on external monitors through VGA/ HDMI/ DVI output from the nurse call system. The system shall be interfaced with IPBX to use as a telephone also.

5.1.3. **Patient Handset without voice facility:**
Whenever the patient needs the attention of any “Nurse”, patient just press the button provided at his/ her bedside. On pressing the button, the alarm shall be annunciated at the Nurse Station by local sounder having volume & tone adjustment informing the nursing staff about the bed no. / Room no. along with type of call (Bed call or WC call or Doctor call) for their necessary action. Patient handset shall be connected to bed head unit through plug in cable. For safety reason, handset shall have antimicrobial coating to avoid infection transfer, shall be shock & spill proof & having suitable colour & symbol for nurse call button on the handset. There shall be call cancel/ reset button either on bed head unit or separate button.

5.1.4. **Patient Handset with voice facility:**
Patient handset shall be connected to whenever the patient needs the attention of any “Nurse”, patient just press the button provided at his/ her bedside. On pressing the button, the alarm shall be annunciated at the Nurse Station informing the nursing staff about the bed no. / Room no. along with type of call (Bed call or WC call or Doctor call) for their necessary action. There shall be speech facility in both patient handset & nurse station with suitable inbuilt microphone & speaker. Nursing staff shall receive the call from nurse station itself & respond to the patient queries. It will reduce the nurse staff movement to patient room. However, if required, nurse staff shall visit the patient room as & when needed by patient. Patient handset shall be connected to bed head unit through plug in cable. For safety reason, handset shall have antimicrobial coating to avoid infection transfer, shall be shock & spill proof & having suitable colour & symbol for nurse call button on the handset. There shall be call cancel/ reset button either on bed head unit or separate button.

5.1.5. **Lamp Module:**
Lamp module shall be installed outside the room/ ward above the door for visual indication of different type of call. There shall be different colour of indication for different type of calls.

Once the patient annunciates the alarm, the signal shall go to the nurse station. The lamp outside the patient room/ ward shall also glow simultaneously red provide a visual alarm. Lamp shall have different colours light to inform about the type of call like red light for bed call, blue light for code blue call etc.

5.1.6. **Doctor Call & Cancel Button:**
Each bed/ ward shall have code blue button (Doctor Call). Doctor call button shall be used only by nurse staff & programmed in such a way to avoid direct code blue call by patient. It shall be a separate programmable button with cancel button. It shall not be in patient handset with nurse call button & shall have separate cancel button. Once nurse press code blue button, call shall go to every nurse station of the hospital or as programmed as per site requirements with room no. & bed no. information so that code blue team available at any nurse station shall be informed & they can reach the patient room on immediate basis.

5.1.7. **Call-Cancel Button for common toilet:**
There shall be nurse call & cancel button with suitable colour/ symbol in common toilet near WC to generate nurse call by patient from WC in case of any emergency. It shall be installed at waist height for easy access. The buttons shall be moisture protected.

Pull cord Button for room/ ward toilet with shower/ bath facility.
There shall be nurse call button with suitable length of pull cord with colour/ symbol for nurse call from the toilet. It shall be installed above shower head preferably in such a way to access from bath area as well as WC. Pull cord shall be detachable & replaceable without changing the unit. The buttons shall be moisture protected & suitable for bath areas.

5.1.8. Central Monitoring Station

Complete nurse call system shall be centrally connected to a PC having a software recording of all the different type of call & cancel with date & time. The software shall record the date & time of call generated by patient & call cancel by nurse with type of call. Software shall be able to generate report on daily, weekly or monthly basis as per requirement. It shall also be possible to put reminder/ highlighted on calls if nursing staff do not attend/ cancel the patient call within specific time decided by the hospital management.

6. INFORMATION DISPLAY SYSTEM:

It is proposed that Information Display System shall be provided for Hospital Building. Information display systems will achieve information sharing in order to significantly improve the hospital management and service level, and enhance the hospital's brand and core competitiveness. This system shall have centralized control over LAN with unified management of video and audio signals, pictures, Text scroll and other multimedia information to be transmitted to various display terminals.

Information display systems will be used to display:

- images, scrolling texts & videos of advertisements,
- to share Internal information's,
- Public information
- Advertisement or Promotions.
- And influencing HITES behaviour.

System Architecture LED Screen, Application Server will be used for Uploading & Displaying movies, PPTs, Screen etc.

System advantages: Centralized control, centralized management.

Real-time: Issue Emergency information, Events, Media / Marketing Info etc.

PC based: It can play any file as per requirement of controller.

The Information Display System shall display welcome messages at reception, waiting & lobby areas of OPD & IPD. Displays can be programmed to show videos that explain medical procedures, healthy eating tips and guidelines, medical innovations, drug information etc.

<table>
<thead>
<tr>
<th>ULTRA HD (4K) Media Player</th>
<th>Technical Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td><strong>HDMI Output Resolution</strong>: Up to 3840x2160 (@60fps)</td>
</tr>
<tr>
<td><strong>HDMI Input Resolution</strong></td>
<td>Up to 1920x1080</td>
</tr>
<tr>
<td><strong>Color Space</strong></td>
<td>RGB 4:4:4, YCbCr 4:4:4, YCbCr 4:2:2(Output)</td>
</tr>
<tr>
<td><strong>CPU</strong></td>
<td>Quad-Core 1.8Ghz</td>
</tr>
<tr>
<td><strong>Memory</strong></td>
<td>2GB DDR3</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>64 GB eMMC 5.1</td>
</tr>
<tr>
<td><strong>Video Codec</strong></td>
<td>H.264 (4Kp30)/ H.265(4Kp60)/ Mp4</td>
</tr>
<tr>
<td><strong>Image Format</strong></td>
<td>Jpeg/ Png</td>
</tr>
<tr>
<td>Audio Format</td>
<td>Mp3</td>
</tr>
<tr>
<td>--------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Beacon (BLE)</td>
<td>Supported</td>
</tr>
<tr>
<td>Watch dog Timer</td>
<td>Supported (External)</td>
</tr>
<tr>
<td>RTC</td>
<td>Supported</td>
</tr>
</tbody>
</table>

**IO Interface**

<table>
<thead>
<tr>
<th>Ethernet</th>
<th>1xRJ45 (GigaLAN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WLAN</td>
<td>802.11 b/g/n, With 2db antenna</td>
</tr>
<tr>
<td>HDMI Out</td>
<td>1xHDMI 2.0 with CEC</td>
</tr>
<tr>
<td>HDMI IN</td>
<td>1xHDMI 1.4b with HDCP</td>
</tr>
<tr>
<td>USB</td>
<td>2xUSB2.0 / 1x Micro USB OTG</td>
</tr>
<tr>
<td>3.5mm Audio Jack</td>
<td>1x2-in-1 (Speaker/Mic-in)</td>
</tr>
<tr>
<td>Digital Stereo Out</td>
<td>1xS/PDIF</td>
</tr>
<tr>
<td>COM Port</td>
<td>1xRs-232 port (Male)</td>
</tr>
<tr>
<td>Expansion Storage</td>
<td>1xMicro SDHC slot</td>
</tr>
</tbody>
</table>

**Mechanical & Enviroment**

<table>
<thead>
<tr>
<th>Dimension (WxDxH)</th>
<th>165x118.5x27mm (6.49”x4.66”x1.06” inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (Net)</td>
<td>415g</td>
</tr>
<tr>
<td>Mounting</td>
<td>Easy Wall mount</td>
</tr>
<tr>
<td>Enviroment</td>
<td>Operating Temp- 40 c to 70 c, Storage Temperature-40 c to 80 c, humidity 5% to 90% (non-condensing)</td>
</tr>
<tr>
<td>Power Adapter</td>
<td>DC 12V, 1.5A</td>
</tr>
<tr>
<td>Certification</td>
<td>CE/FCC</td>
</tr>
</tbody>
</table>

**ULTRA HD (4K) Display Panel**

<table>
<thead>
<tr>
<th>Description</th>
<th>Technical Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen Size</td>
<td>43” or better</td>
</tr>
<tr>
<td>Light Source</td>
<td>Direct LED</td>
</tr>
<tr>
<td>Panel Type</td>
<td>IPS</td>
</tr>
<tr>
<td>Display Orientation</td>
<td>Landscape / Portrait</td>
</tr>
<tr>
<td>Usage (hrs/days)</td>
<td>18 hrs / 7 days</td>
</tr>
<tr>
<td>Active Area (mm)</td>
<td>941.2 (H) x 529.2 (V)</td>
</tr>
<tr>
<td>Resolution (pixel)</td>
<td>UHD 3840 x 2160</td>
</tr>
<tr>
<td>Aspect Ratio</td>
<td>16:9</td>
</tr>
<tr>
<td>Brightness (typ.) (nits; cd/m²)</td>
<td>380</td>
</tr>
<tr>
<td>Contrast Ratio (typ.)</td>
<td>1200:1</td>
</tr>
<tr>
<td>Response Time (ms)</td>
<td>8</td>
</tr>
<tr>
<td>Pixel Pitch(mm)</td>
<td>0.25 (H) x 0.25 (V)</td>
</tr>
<tr>
<td>Frame Rate</td>
<td>60 Hz</td>
</tr>
</tbody>
</table>
### Technical Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viewing Angle</td>
<td>178 degree (H) / 178 degree (V)</td>
</tr>
<tr>
<td>Light Life (typ) (hrs)</td>
<td>30,000</td>
</tr>
<tr>
<td>Panel Surface</td>
<td>AG, Haze 3%</td>
</tr>
<tr>
<td>System Memory</td>
<td>2GB</td>
</tr>
<tr>
<td>Storage</td>
<td>8GB</td>
</tr>
<tr>
<td>OS</td>
<td>Android 4.3</td>
</tr>
<tr>
<td>Voltage</td>
<td>100V~240V, 50-60Hz</td>
</tr>
<tr>
<td>Maximum (Watt)</td>
<td>98W</td>
</tr>
<tr>
<td>Typical (Watt)</td>
<td>53W</td>
</tr>
<tr>
<td>Standby (Watt)</td>
<td>&lt;0.5W</td>
</tr>
<tr>
<td>Operation Temp (°C)</td>
<td>0°C ~ 40°C</td>
</tr>
<tr>
<td>Operating Humidity</td>
<td>10% ~ 80% RH Non-Condensing</td>
</tr>
<tr>
<td>Internal Speaker</td>
<td>8W x 2</td>
</tr>
<tr>
<td>Input/Output Ports</td>
<td></td>
</tr>
<tr>
<td>VGA In</td>
<td>x1</td>
</tr>
<tr>
<td>HDMI Input</td>
<td>x3 (1.4 x 3)</td>
</tr>
<tr>
<td>MHL</td>
<td>Yes</td>
</tr>
<tr>
<td>Composite video In</td>
<td>x1</td>
</tr>
<tr>
<td>Composite video Out</td>
<td>x1</td>
</tr>
<tr>
<td>Component In (YPbPr, RCA)</td>
<td>x1</td>
</tr>
<tr>
<td>Component Out (YPbPr, RCA)</td>
<td>No</td>
</tr>
<tr>
<td>Audio Input (L/R, RCA)</td>
<td>x1</td>
</tr>
<tr>
<td>Line out (3.5mm)</td>
<td>x1</td>
</tr>
<tr>
<td>RJ45 Port</td>
<td>x1</td>
</tr>
<tr>
<td>USB (Type A)</td>
<td>x4 (2.0 x 3; 3.0 x 1)</td>
</tr>
<tr>
<td>Power (AC) Input</td>
<td>x1</td>
</tr>
<tr>
<td>Weight (without packing / with packing) (kg)</td>
<td>9.5 / 12.0</td>
</tr>
<tr>
<td>Bezel Width (T/B/L/R) (mm)</td>
<td>11.7 / 18.1 / 11.7 / 11.7</td>
</tr>
<tr>
<td>Wall Mounting (VESA) (mm)</td>
<td>200 x 300</td>
</tr>
</tbody>
</table>

### Audio-Video System & Stage Lighting

#### 7.1. Scope of Work

The scope of work covers design, supply, installation, testing and commissioning of following facilities for Auditorium, Conference Rooms and Lecture Theatres at AIIMS Complex:

- Audio System for Auditorium, Conference Rooms & Lecture Theatres
- Lighting System embedded in Acoustic Interior Works for Auditorium
- Video Projection & Control System for Auditorium, Conference Rooms & Lecture Theatres
- Stage Lighting & Stage Furnishing for Auditorium
7.2. Followings are the specifications of the different devices:

I. **HD CODEC UNIT, A1 MICROPHONE AND REMOTE CONTROL:**

   H.320, H.323 and SIP compliant H.261, H.263 and H.264 video coding support H.261, H.263 and H.264 video coding support G.728,G.722 and G.711 audio coding support Built-in Acoustic Echo canceller and Noise Reduction System should be capable to do automatic Gain Control, Noise Suppression and must have Instant Adaptation Echo Cancellation with Audio System should be able to connect at speeds from 128 kbps to 10 Mbps in multiples of 128kbps on IP and 768 kbps on ISDN System should support Dual Network support (LAN and WAN) The system should be upgradeable to 5+1 MCU ( Multi Conferencing Unit System should support Dual monitor mode System must be equipped with two number of Omni directional High Definition Microphone Array with mute button on Mic or Remote control It should be possible to integrate the system with high definition mic mixer for larger room coverage System should support Two images, in one monitor. Should be able to support H.239 for sharing of video and graphics content during the video call.

II. **HD COMMUNICATION COLOR CEILING CAMERA:**

   To support 1920 x 1080 with 10X optical zoom or higher, +90 deg pan range,+15/-25 deg tilt range , FOV 70 deg in order to accept HD resolution video Capability to support 16:9 for supporting High defini.

III. **HD MCU MULTI CONFERENCING LICENCE (5+1):**

   Connect up to 5 remote site

IV. **DATA SOLUTION LICENSE :**

   To share the computer data between two or more location.

V. **Gooseneck Microphone(12”) with on/off Base:**

   - Frequency Response : 50 to 17000 Hz
   - Output Impedance : up to 180Ω
   - Signal to noise ratio at 94 dB SPL Cardioid
   - Open circuit sensitivity at 1 kHz, ref. 1V/Pascal–35.0 dB (17.8 mV
   - Maximum SPL (1 kHz at 1% THD, 1 kΩ load) 124.2 dB
   - Maximum Equivalent output noise : 28.0 dB
   - Dynamic Range at 1 kΩ Load 96.2 dB
   - Power Requirements 11 to 52 Vdc phantom, 2.0 mA

VI. **Chairman (19 inch.) Microphone with on/off Base:**

   - Frequency Response : 50 to 17000 Hz
   - Output Impedance : up to 180Ω
   - Signal to noise ratio at 94 dB SPL Cardioid
   - Open circuit sensitivity at 1 kHz, ref. 1V/Pascal–35.0 dB (17.8 mV
   - Maximum SPL (1 kHz at 1% THD, 1 kΩ load) 124.2 dB
   - Maximum Equivalent output noise : 28.0 dB
   - Dynamic Range at 1 kΩ Load 96.2 dB
- Power Requirements 11 to 52 Vdc phantom, 2.0 mA
- Microphone will be ‘OFF’ after speech in 45 seconds
- The indication lamp will be ON when the microphone is turned on and Microphone is supplied power by main unit.

VII. Wireless Handheld Microphone :-
- Frequency Response 50 Hz to 15kHz
- RF Level Switch between 1mW and 10mW
- Power and battery status LED System Distortion: <1% (ref. ±48 kHz deviation, 1 kHz tone)
- Transmitter Type: Handheld
- RF Output Power: 10mW
- Audio Input Level: -19 dBV (XLR), -5 dBV (1/4”)
- Dynamic Range: >90dB, A-weighted
- Available Frequencies: between 794–806 MHz
- Up to 8 selectable channels
- Up to 4 compatible systems
- Antenna Switching Diversity
- Audio Output Connector: XLR balanced and 1/4” unbalanced
- Mic / Line Switch
- Operating Range: 75m
- Microphone will be ‘OFF’ after speech in 45 seconds
- The indication lamp will be ON when the microphone is turned on and Microphone is supplied power by main unit.

VIII. Digital Automatic Mixer/DSP:-
- Channel Microphone input
- Two Aux-level input
- LED indication
- Front-panel headphones output with level control
- Frequency Response 50 Hz to 20000Hz (±1 dB)
- Hardware/Software Control Adjust Eatings directly on the front and back panels or through the browser-based control software
- Equalization inbuilt
- Phantom Power up to 48 Vdc
- Dual Mixer Mode Route two entirely different and independent automixes to mix A and B outputs.
• Control System Compatible
• Linking capability
• Mounts in a single 19” rack space via integral rack-mount
• Intellimix operational concept
• capability for system upto 96 Microphone
• Logic Operation will be available
• AD/DA Converter 24-bit, 48 kHz, 113 dB dynamic range typical
• Last Mic Lock-On (LMLO) Keeps the most recently activated microphone open until aEcestor microphone is activated
• Dante™ Digital Audio Multichannel audio over Ethernet
• Remote Control Convenient browser-based software
• Digital Feedback Reduction

IX. Wall mounted / Ceiling speaker:-
• Power RMS Out put Up to 15W
• Over all Dia up to 8”
• Frequency Response 80 to 18khz
• Line Voltage 70V/100V
• Driver Sensitivity up to 87db
• Speaker Type Coaxial

X. Amplifier :-
• Rated out put RMS Wattage 240W/480W/500W
• Sensitivity 1V,100mv @10Kohms
• Impedance @10k ohms
• Signal to noise Ratio up to 86db
• AC Power consumption up to 640W
• Input interface XLR
• Battery Voltage 24VDC
• Out put interface XLR & 6.3mm Phone Jack
• Total Harmonic Distortion < =1% at 1khz
• Speaker out put 8Ω ,70V/100V
• Main voltage 115V/230V
• Power ON indicator
• Mountable Desktop & 19” rack.

XI. Feedback Destroyer:-
• Maximum Output Level +20dB 2 Output
• Dynamic Range Eat Less than 119dB
• Balance Impedance EAt Less than 120Ohms
• Minimum Frequency Response 20Hz to 20Khz
• Filter Per Channel at least 24 Programmable
• Operating Level Switch required Per Channel wise
• Cross Talk Input to Output atleast 80dB EAise level

XII. **Voice Recorder :-**
• Recording to SD(HC) cards
• Interface Balanced & Unbalanced
• 19‖ Rack mountable
• Format Support MP3
• Date Transfer through USB to computer
• Power on auto play
• Input sensitivity 500mvrms
• Input impedance 75Ω
• USB Connection to PC for fast secure download
• to read LCD display
• Dictation/Conference/Lecture recording Facility
• Max SD Card 32GB

XIII. **Hydraulic Pop Up Box on Conference Table :-**
SITC of Hydraulic Pop Up Box for connecting , computer Tabletop Interconnet box Inbuilt Port, VGA/HDMI,Power, Audio

XIV. **Motorized Screen:-**
• Size:7 ft X 5ft , Width 7ft & Height 5ft, diagonal 100" ,
• High Contrast Matte White,
• Video Spectra 1.5,
• Remote range up to 40mtrs.

XV. **Multimedia Projector:-**
IN: Video Input connector: BNC, LAN Connector: RJ-45, 100BASE-TX (Shared with HDBaseT), USB: Type A, Type B, Remote: RS-232 connector: D-sub 9-pin (male)

XVI. 16- Professional Full HD LED Panel 70":
Screen Size: 70", Audio output 10w+10w, USB Auto play back, HDMI 2, USB 2, Component, Composite, LAN Port , Smart Energy Saving

XVII. LED Interactive Monitor 19" for Chairman:
19inch display with SXGA (1280x1024) resolution and wide viewing angle, Built in DVI /VGA Port, Aspect Ratio- 16:9. Tablet Resolution 4000 line per inch, pressure sensitivity 2048 level,

XVIII. DVD Player with HDMI:
Video DAC 12bit/108MHz , USB Content Playback ; Multi Disc and Format Playback Video Format NTSC / PAL, Aspect ratio 16:9 Digital Output 96khz/24bit

XIX. Audio Video Control System:-
- RS 232 Serial Port: 5 nos or more inbuilt or with additional card/module
- Ethernet Monitoring & Control of AV devices, IR/Serial Port: 2nos or more
- Digital I/O ports: 4nos or more
- Low-voltage relay ports: 4 or more
- Integrated or supplied with IR Learner
- SDRAM: 512 mb or more
  4GB or more
  External power pack included
  Have Option & license to connect third party touch interface like iPad for control

XX. iLux Integrated Lighting System - International Version, 230V :-
- Wall mount integrated lighting and shade control
- 6 channels of dimming or switching
- 6 groups of shade and drape control
- Linkable for up to 54 lighting channels and 54 shade groups
- Up to 16 user-EATable scenes
- configurable "rocker" buttons with customizable label strip
- Large ON and OFF buttons

XXI. IR probes:-
The IRP2 is an IR (infra-red) emitter probe designed to adhere directly over the IR sensor window of a television, DVD player, or any other IR controllable device. The IRP2 connects to any Crestron control system with a 2-pin terminal block type Crestron IR port, providing a 1-way IR control interface to the device. The IRP2 is composed of an infrared LED housed in a miniature shell. Its integral 7 foot cable may be extended up to 1000 feet using ordinary twisted pair cable. Includes IR mask and two-sided tape for mounting.

XXII. HDMI Switcher 4 in 4 out for laptop source:-
Each port supports HDMI inputs. Supports high video resolution up to 1920 x 1200 including 720p, 1080i & even 1080p. Interface compatible with Transition Minimized Differential
Signaling (TMDS). Supports both video and audio signals. Supports signaling rates up to 1.65Gbps of UXGA Display, Video Bandwidth up to 1.65GHz

XXIII. Speaker Cable :-

2 core of high quality with minimum data loss, 1.13mm, AWG-16, foiled shielded, twisted-pair, Capacitance: 8.5 pF (per foot at a frequency of 10 kHz), Conductor Stranded bare copper, Insulation PVC.

XXIV. Microphone Cable:-

High quality with minimum data loss, 0.4mm, AWG-20, ruggedness, flexibility, flex life and interference immunity. Low impedance, Operating Temperature Range: -30°C to +60°C, Overall Nominal Diameter: 5mm

XXV. Cat6 Cable:-

Conductor Size, 23AWG bare solid copper. Total Wires 8, Drain Wire solid 23AWG tinned copper, Propagation Delay Skew 35ns/100m max. Impedance, 100Ω. DC Resistance 73Ω/km (21Ω/1000ft) nominal, MAX Resistance Unbalanced 2%. Capacitance 1.2pF/m max

XXVI. Connector XLR Male / Female:-

Capacitance between contacts ≤ 4 pF, Contact resistance ≤ 3 mΩ (inner), Dielectric strength 1.5 kVdc, Insulation resistance > 10 GΩ (initial), Current per contact 16 A, Voltage 50 V

XXVII. Equipment Rack:-

With lockable rear and front glass door, power strip, castor wheel for easy movement & top knock-out plate 16-gauge steel tops, bottoms & sides Laser-cut 1/8" thick internal steel braces for strength 1 pair fully-adjustable front rackrail Large cable entry in bottom Grounding and bonding stud installed in base Finished in a durable textured powder coat for all the above audio main systems.

XXVIII. Projector Screen:-


XXIX. Other Items:

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>Item Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Digital Projector 1-chip DLP Laser phosphor, 1920X1200 native resolution, Brightness 13,500 lumens, Contrast Ratio : up to 700000:1, Lamp life 20000 hours, Motorized horizontal and vertical lens offset , 3D ready, Inputs: HDMI x 2, DVI-D, Display Port , HD1.5, HD base T , Controls: RS232 in/out, RS422 in, Ethernet (10/100), USB, device, should be complete with lens</td>
</tr>
</tbody>
</table>

Technical Specification

<table>
<thead>
<tr>
<th>Technology</th>
<th>1-DLP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brightness</td>
<td>13500 Lumens</td>
</tr>
<tr>
<td>Contrast Ratio</td>
<td>7,500:1</td>
</tr>
<tr>
<td>Native resolution</td>
<td>1920 x 1200 pixels</td>
</tr>
<tr>
<td>Aspect Ratio</td>
<td>16:10</td>
</tr>
<tr>
<td>Illumination system</td>
<td>Laser phosphor</td>
</tr>
<tr>
<td>---------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Typical lifetime</td>
<td>20,000 hours</td>
</tr>
<tr>
<td>Inputs</td>
<td>HDMI x 2</td>
</tr>
<tr>
<td></td>
<td>DVI-D</td>
</tr>
<tr>
<td></td>
<td>HD15</td>
</tr>
<tr>
<td></td>
<td>HD Base T</td>
</tr>
<tr>
<td>Outputs</td>
<td>DVI-D</td>
</tr>
<tr>
<td>Control and networking</td>
<td>RS232 In</td>
</tr>
<tr>
<td></td>
<td>HD Base T</td>
</tr>
</tbody>
</table>

2
55-inch Display Panel, 4K UHD 3840 x 2160 (16:9) Resolution, Brightness 400 nits or more, Contrast ratio 1200:1 or better, Inputs HDMI, Display Port, VGA, Video In, Audio inputs, Audio output

Technical Specification

<table>
<thead>
<tr>
<th>Screen size (diagonal)</th>
<th>55”, Direct-lit LED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brightness</td>
<td>400 nits (cd/m2)</td>
</tr>
<tr>
<td>Contrast Ratio</td>
<td>12,00 : 1</td>
</tr>
<tr>
<td>Resolution</td>
<td>3840 x 2160 (16:9)</td>
</tr>
<tr>
<td>Viewing angle</td>
<td>178° h/v</td>
</tr>
<tr>
<td>Response time</td>
<td>8ms typical</td>
</tr>
<tr>
<td>Video inputs</td>
<td>2 x HDMI (Ver 2.0, HDCP 2.2)</td>
</tr>
<tr>
<td>Display Port</td>
<td></td>
</tr>
<tr>
<td>VGA</td>
<td></td>
</tr>
<tr>
<td>YPbPr</td>
<td></td>
</tr>
</tbody>
</table>

Video outputs

| Display Port           |
| HD15                   |
| RCA (L/R) line out     |
| Control inputs         | RS-232               |

3
70-inch Display Panel, 4K UHD 3840 x 2160 (16:9) Resolution, Brightness 400 nits or more, Contrast ratio 1200:1 or better, Inputs HDMI, Display Port, VGA, Video In, Audio inputs, Audio outputs

Technical Specification

<p>| Screen size (diagonal) | 70”, Direct-lit LED |</p>
<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brightness</td>
<td>400 nits (cd/m2)</td>
</tr>
<tr>
<td>Contrast Ratio</td>
<td>12,00 : 1</td>
</tr>
<tr>
<td>Resolution</td>
<td>3840 x 2160 (16:9)</td>
</tr>
<tr>
<td>Viewing angle</td>
<td>178° h/v</td>
</tr>
<tr>
<td>Response time</td>
<td>8ms typical</td>
</tr>
<tr>
<td>Video inputs</td>
<td>2 x HDMI (Ver 2.0, HDCP 2.2)</td>
</tr>
<tr>
<td></td>
<td>DisplayPort</td>
</tr>
<tr>
<td></td>
<td>VGA</td>
</tr>
<tr>
<td></td>
<td>YPbPr</td>
</tr>
<tr>
<td>Video outputs</td>
<td>Display Port</td>
</tr>
<tr>
<td></td>
<td>HDMI</td>
</tr>
<tr>
<td></td>
<td>RCA (L/R) line out</td>
</tr>
<tr>
<td>Control inputs</td>
<td>RS-232</td>
</tr>
</tbody>
</table>

4. Wireless Presentation and Collaboration Solution, Enables wireless presentation of HD content using laptops, tablets, and smart phones, Compatible with Windows, OS X, Apple iOS, and Android, Displays up to four presentation sources at once in Quad View, Supports up to 32 or more simultaneous presenter connections, Supports display resolutions up to Full HD 1080p and UXGA/WUXGA, Provides HDMI, VGA

Technical Specification

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compatible</td>
<td>Windows, Android and iOS operating system</td>
</tr>
<tr>
<td>Displays up to four presentation</td>
<td>Displays up to four presentation sources at once in Quad View</td>
</tr>
<tr>
<td>resolutions up to Full HD 1080p</td>
<td>Display resolutions up to Full HD 1080p and UXGA/WUXGA</td>
</tr>
<tr>
<td>Provides HDMI, VGA/Display Port,</td>
<td>Provides HDMI, VGA/Display Port, and analog audio outputs</td>
</tr>
<tr>
<td>and analog audio outputs</td>
<td>Choice of connection methods accommodates all types of users and organizations</td>
</tr>
<tr>
<td>Supports up to 32 or more</td>
<td>Supports up to 32 or more simultaneous presenter connections</td>
</tr>
<tr>
<td>simultaneous presenter connections</td>
<td>High quality video streaming, supports full HD 1080p/60</td>
</tr>
</tbody>
</table>

5. Digital Modular Matrix Switcher, Modular Design, 8 Input & 8 Output frame, Pixel Accurate Reclocking, Frame Detector and Input Signal Analysis, Zero frame Delay, Combine non-HDCP and HDCP capable, 1 Preview input & Output Port (Video Signals) with all require accessories

Technical Specification

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame Size</td>
<td>8 Inputs and 8 Outputs</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>Combine non-HDCP and HDCP capable I/O boards</td>
</tr>
<tr>
<td></td>
<td>Advanced error handling</td>
</tr>
<tr>
<td></td>
<td>Advanced EDID Management</td>
</tr>
<tr>
<td></td>
<td>Hybrid Modular and Cross Platform technology</td>
</tr>
<tr>
<td></td>
<td>Zero frame Delay</td>
</tr>
<tr>
<td></td>
<td>HDMI, 4K x 2K, 3D and Display port 1.1 video signals</td>
</tr>
<tr>
<td></td>
<td>Bi-directional RS-232 extension</td>
</tr>
<tr>
<td></td>
<td>DVI/HDMI Test input</td>
</tr>
<tr>
<td></td>
<td>DVI/HDMI Preview Output</td>
</tr>
<tr>
<td>6</td>
<td>Input Cards: Combine / Combination of 4 HD Base T &amp; 4 HDMI input port, HDMI 1.4; DVI and HDCP compliant, support 4K, UHD (30Hz RGB 4:4:4, 60Hz YCbCr 4:2:0), Supports all HDMI audio formats, PoE add-on option with all required accessories</td>
</tr>
<tr>
<td></td>
<td>Technical Specification</td>
</tr>
<tr>
<td></td>
<td>Four HDMI and Four HD Base T</td>
</tr>
<tr>
<td></td>
<td>HDMI extension supporting 3D and 4K</td>
</tr>
<tr>
<td></td>
<td>Accepts HDMI, Ethernet, RS-232 over one CAT6A Cable up to 170m</td>
</tr>
<tr>
<td></td>
<td>HDMI 1.4; DVI and HDCP compliant</td>
</tr>
<tr>
<td></td>
<td>supports 4K, UHD (30Hz RGB 4:4:4, 60Hz YCbCr 4:2:0)</td>
</tr>
<tr>
<td></td>
<td>48-bit color depth</td>
</tr>
<tr>
<td></td>
<td>Supports all HDMI audio formats</td>
</tr>
<tr>
<td></td>
<td>Bi-directional RS-232 and Ethernet transmission</td>
</tr>
<tr>
<td></td>
<td>HDCP enable/disable mode</td>
</tr>
<tr>
<td></td>
<td>Pixel Accurate Relocking</td>
</tr>
<tr>
<td></td>
<td>Advanced EDID Management</td>
</tr>
<tr>
<td></td>
<td>compatible with deep color, Dolby True HD and DTS-HD audio</td>
</tr>
<tr>
<td>7</td>
<td>Output Cards: Combine / Combination of 4 HD Base T &amp; 4 HDMI output port, HDMI 1.4; DVI and HDCP compliant, support 4K, UHD (30Hz RGB 4:4:4, 60Hz YCbCr 4:2:0), Supports all HDMI audio formats, Audio De-Embedding output, PoE add-on option with all required accessories</td>
</tr>
<tr>
<td></td>
<td>Technical Specification</td>
</tr>
<tr>
<td></td>
<td>Four HDMI and Four HD Base T</td>
</tr>
</tbody>
</table>
### Technical Specification

<table>
<thead>
<tr>
<th><strong>Input Port</strong></th>
<th><strong>Output Port</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 HDMI, 1 VGA and 1 Display Port Input ports</td>
<td>1 HD Base T</td>
</tr>
<tr>
<td>1 Balanced Audio Input ports</td>
<td>Support 4K/UHD (30Hz RGB 4:4:4, 60Hz YCbCr 4:2:0) and 3D capabilities</td>
</tr>
<tr>
<td>Extends HDMI, VGA, Display Port, Audio, Ethernet, RS-232, IR over a single CATx cable up to 170 m distance</td>
<td>Extends HDMI, VGA, Display Port, Audio, Ethernet, RS-232, IR over a single up to 170 mtr</td>
</tr>
</tbody>
</table>

### HDMI extension supporting 3D and 4K

- Accepts HDMI, Ethernet, RS-232 over one CAT6A Cable up to 170m
- HDMI 1.4; DVI and HDCP compliant
- Supports 4K, UHD (30Hz RGB 4:4:4, 60Hz YCbCr 4:2:0)
- 48-bit color depth
- Supports all HDMI audio formats
- Bi-directional RS-232 and Ethernet transmission
- HDCP enable/disable mode
- Pixel Accurate Relocking
- Advanced EDID Management
- compatible with deep color, Dolby True HD and DTS-HD audio

### Active Wall Plate: VGA, HDMI, Display Port and Audio Input, 4K/UHD (30Hz RGB 4:4:4, 60Hz YCbCr 4:2:0) support and 3D capabilities, VGA, YPrPb, HDMI1.4 and DP 1.1 signal support, Auto select mode, HDCP compliant, CEC, EDID transparent, HD Base T compatibility, Extends HDMI, Display Port, VGA, Audio, Ethernet, RS-232, IR over a single CATx cable up to 170 m distance

### Event Manager

- Bi-directional RS-232 and IR
- Breakaway audio and video switching
- HDMI 1.4, HDCP 1.4 and DVI 1.0 compliant
- HDCP enable/disable function
- HD Base T compatible
- Advanced EDID Management
<table>
<thead>
<tr>
<th></th>
<th>No video compression</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bi-directional RS-232 and IR extension</td>
<td></td>
</tr>
</tbody>
</table>

9. HDMI Transmitter, 1 HD Base T output and 1 HDMI Input, HDMI extension supporting 4K/UHD (30Hz RGB 4:4:4, 60Hz YCbCr 4:2:0) and 3D capabilities over one CATx cable up to 170 m distance, Bi-directional RS-232 and IR, HDCP 2.2 compliant, CEC, EDID transparent

Technical Specification

| Input Port | 1 HDMI |
| Output port | 1 HD Base T |
| HDMI 1.4, HDCP 1.4 and DVI 1.0 compliant |   |
| Bi-directional RS-232 extension |   |
| supporting 4K/UHD (30Hz RGB 4:4:4, 60Hz YCbCr 4:2:0) and 3D capabilities |   |
| Extends DVI, HDMI, Ethernet, RS-232, IR over CAT6 cable up to 170 m distance |   |
| HDCP 2.2 compliant, CEC, EDID transparent |   |
| No signal latency, zero frame delay |   |
| HDBase-T compatible |   |
| Transparent EDID pass-through |   |

10. HDMI Receiver, 1 HD Base T input and 1 HDMI Output, HDMI extension supporting 4K/UHD (30Hz RGB 4:4:4, 60Hz YCbCr 4:2:0) and 3D capabilities over one CATx cable up to 170 m distance, Bi-directional RS-232 and IR, HDCP 2.2 compliant, CEC, EDID transparent

Technical Specification

<p>| Input Port | 1 HD Base T |
| Output port | 1 HDMI |
| HDMI 1.4, HDCP 1.4 and DVI 1.0 compliant |   |
| Bi-directional RS-232 extension |   |
| supporting 4K/UHD (30Hz RGB 4:4:4, 60Hz YCbCr 4:2:0) and 3D capabilities |   |
| Extends DVI, HDMI, Ethernet, RS-232, IR over CAT6 cable up to 170 m distance |   |
| HDCP 2.2 compliant, CEC, EDID transparent |   |
| No signal latency, zero frame delay |   |</p>
<table>
<thead>
<tr>
<th>11</th>
<th>HD Base T compatible</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transparent EDID pass-through</td>
</tr>
</tbody>
</table>

Digital Audio Processor with 8 AEC Mic Input, 2 Mic / Line Input, 6 Line Output, Multichannel USB Interface, GPIO Port, Delay, Limiter, Feedback Suppressor, Equalization audio setting parameters, LAN Control complete with Wall panel control with 4 selectable zones/source and volume control

**Technical Specification**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total inputs</td>
<td>10 or more</td>
</tr>
<tr>
<td>AEC Inputs</td>
<td>8</td>
</tr>
<tr>
<td>Outputs</td>
<td>6</td>
</tr>
<tr>
<td>Phantom power</td>
<td>+48 VDC</td>
</tr>
<tr>
<td>USB Audio</td>
<td>2 in / 2 out</td>
</tr>
<tr>
<td>GPIO</td>
<td>6</td>
</tr>
<tr>
<td>THD+N</td>
<td>&lt; 0.005% or better</td>
</tr>
<tr>
<td>Dynamic range</td>
<td>&gt; 105 dB or better</td>
</tr>
<tr>
<td>Features</td>
<td>Auto mixing</td>
</tr>
<tr>
<td></td>
<td>Open architecture software configurable functionality</td>
</tr>
<tr>
<td></td>
<td>USB audio connection</td>
</tr>
<tr>
<td></td>
<td>RS232 connector for 3rd party control systems</td>
</tr>
</tbody>
</table>

**12** Array Microphone for the Podium Having minimum 4 Nos of Capsule should pick up at least from 3 feet with Push-To-Talk and Push-To-Mute functions

**Technical Specification**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transducer type</td>
<td>Electret condenser</td>
</tr>
<tr>
<td>Polar pattern</td>
<td>Corridor</td>
</tr>
<tr>
<td>Frequency response</td>
<td>90 - 20,000 Hz</td>
</tr>
<tr>
<td>Nominal impedance</td>
<td>&lt; 200 ohm</td>
</tr>
</tbody>
</table>

**13** Stage Lighting System: COB LED Fixture : Equipped with 4*LED Cold White / Warm White Two In One, Each LED 100 W, Beam angle 45°, Field angle 90°, Projection can be adjusted from 0-70° as desired, DMX 512 protocol, master/slave, auto, sound active with adjustable sound sensitivity, 6/13 DMX channel modes

**Technical Specification**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRI</td>
<td>RA95</td>
</tr>
<tr>
<td>Dimming Mode</td>
<td>Linear, S-Curve, Square Law, Inverse Square Law</td>
</tr>
<tr>
<td></td>
<td>Beam angle 53 degree</td>
</tr>
<tr>
<td>Field Angle 68 degree</td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td></td>
</tr>
<tr>
<td>4 LED Cold white/Warm two in one 100 W each</td>
<td></td>
</tr>
<tr>
<td>Intelligent Temp. Controlling</td>
<td></td>
</tr>
<tr>
<td>Separate Strobe</td>
<td></td>
</tr>
<tr>
<td>DMX512 Support</td>
<td></td>
</tr>
<tr>
<td>master/slave, auto, sound active with adjustable sound sensitivity</td>
<td></td>
</tr>
</tbody>
</table>

Stage Lighting System: COB LED Bar: Equipped with 8 CoB RGBW four in one, Each 40W, Total 320W, Intelligent temperature self controlling, beam angle 20°, field angle 45°, DMX 512 protocol, master/slave, auto, sound active with adjustable sound sensitivity

Technical Specification

<table>
<thead>
<tr>
<th>Dimming Mode</th>
<th>Linear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam angle 53 degree</td>
<td></td>
</tr>
<tr>
<td>Field Angle 68 degree</td>
<td></td>
</tr>
<tr>
<td>4 LED RGBW four in one 40 W each</td>
<td></td>
</tr>
<tr>
<td>Intelligent Temp. Controlling</td>
<td></td>
</tr>
<tr>
<td>Separate Strobe</td>
<td></td>
</tr>
<tr>
<td>DMX512 Support</td>
<td></td>
</tr>
<tr>
<td>master/slave, auto, sound active with adjustable sound sensitivity</td>
<td></td>
</tr>
</tbody>
</table>

DMX Channel Mode: 5/11/39 modes

Stage Lighting System: Parcon Light, CoB LED (Chip on Board), 150W RGB three in one, DMX, Master/Slave, Stand Alone & Sound Active, Beam angle 40 degrees, field angle 80 degrees

Technical Specification

<table>
<thead>
<tr>
<th>LED</th>
<th>COB High MCD RGB Three in one 150W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational Mode</td>
<td>DMX, Master/Slave, Stand Alone and sound active</td>
</tr>
<tr>
<td>Angle</td>
<td>Beam Angle 40 degree, Field Angle 80 degree</td>
</tr>
<tr>
<td>Mode</td>
<td>3/5/8 DMX Channel Modes</td>
</tr>
<tr>
<td>Shutter</td>
<td>Pulse effect, Strobe</td>
</tr>
</tbody>
</table>

Stage Lighting System: Parcon Light, CoB LED (Chip on Board), 200W RGBA four in one, DMX, Master/Slave, Stand Alone & Sound Active, Beam angle 40 degrees, field angle 80 degrees
<table>
<thead>
<tr>
<th>Technical Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LED</strong></td>
</tr>
<tr>
<td><strong>Operational Mode</strong></td>
</tr>
<tr>
<td><strong>Angle</strong></td>
</tr>
<tr>
<td><strong>Mode</strong></td>
</tr>
<tr>
<td><strong>Shutter</strong></td>
</tr>
</tbody>
</table>

**17** Control Processor, one RS-232/422/485 COM ports, two RS-232 COM ports, Eight IR/serial, eight relay, and eight Versiport I/O ports, Programmable event scheduling

<table>
<thead>
<tr>
<th>Technical Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprise-class control system</td>
</tr>
<tr>
<td>Onboard 512MB RAM &amp; 4GB Flash memory</td>
</tr>
<tr>
<td>SNMP remote management support</td>
</tr>
<tr>
<td>One RS-232/422/485 COM port</td>
</tr>
<tr>
<td>Two RS-232 COM ports</td>
</tr>
<tr>
<td>Eight IR/serial, eight relay, and eight I/O ports</td>
</tr>
<tr>
<td>Programmable event scheduling</td>
</tr>
<tr>
<td>TLS, SSL, SSH, and SFTP network security protocols</td>
</tr>
<tr>
<td>IPhone, iPad, and Android control app support</td>
</tr>
</tbody>
</table>

**18** 10" widescreen active-matrix color Touch Panel, 1280 x 800 WXGA display resolution, Capacitive touch screen technology, Multi-touch capable, PoE or PoE+ network powered with Table top kit and power supply

<table>
<thead>
<tr>
<th>Technical Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Screen Size</strong></td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
</tr>
<tr>
<td><strong>Touch Technology</strong></td>
</tr>
<tr>
<td><strong>Multi-touch</strong></td>
</tr>
<tr>
<td><strong>Auto-brightness control</strong></td>
</tr>
<tr>
<td><strong>Single-wire Ethernet connectivity</strong></td>
</tr>
<tr>
<td><strong>PoE or PoE+ network powered</strong></td>
</tr>
<tr>
<td><strong>Tabletop and swivel mount</strong></td>
</tr>
<tr>
<td>19</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td><strong>Technical Specification</strong></td>
</tr>
<tr>
<td><strong>Capture Options</strong></td>
</tr>
<tr>
<td><strong>Input format</strong></td>
</tr>
<tr>
<td>HDMI and YPbPr: 720P@50@60, 1080i@50@60, 1080p@25@30@50@60, CVBS: 480i, 576i (NTSC and PAL), VGA</td>
</tr>
<tr>
<td>Supports input from computer, visualize and electric whiteboard, Encoding</td>
</tr>
<tr>
<td>Encoding: H.264 HP</td>
</tr>
<tr>
<td>High frame rate up to 30fps</td>
</tr>
<tr>
<td>Bitrates from 128Kbps to 20Mbps</td>
</tr>
<tr>
<td>Audio Supports balanced, and unbalanced audio in</td>
</tr>
<tr>
<td>File Format, MP4</td>
</tr>
<tr>
<td>Resolution: D1, 720p, 1080p</td>
</tr>
<tr>
<td>Picture-in-picture and Picture-by-picture</td>
</tr>
<tr>
<td>Storage, Capacity of 1TB, Around 1000 hours recording</td>
</tr>
<tr>
<td>Supports FTP, Local Decoding</td>
</tr>
<tr>
<td>Supports PTZ camera control</td>
</tr>
<tr>
<td><strong>20</strong></td>
</tr>
<tr>
<td><strong>Technical Specification</strong></td>
</tr>
<tr>
<td>Camera incorporates a 1/2.7-type HD CMOS image sensor with over 2 million effective pixels, support up to 1080p30 resolution</td>
</tr>
<tr>
<td>Camera supports simultaneous video outputs in multiple video interfaces including HDMI, HD-SDI, CVBS</td>
</tr>
<tr>
<td>Reliable, Wide-Range, Quiet and Quick Pan/Tilt Mechanism</td>
</tr>
<tr>
<td>Camera supports multiple protocols</td>
</tr>
<tr>
<td>Camera can store up to 245 presets, those settings can be retained even after camera is shut off, can keeps high</td>
</tr>
<tr>
<td>S.No.</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

**Main Front Stage Curtain**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Items Description</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Type</td>
<td>Horizontal / Vertical Sliding</td>
</tr>
<tr>
<td>2</td>
<td>Motor</td>
<td>1 HP Single phase / three Phase (Geared)</td>
</tr>
<tr>
<td>3</td>
<td>Minimum Overlap</td>
<td>900 mm</td>
</tr>
<tr>
<td>4</td>
<td>Curtain Size Nominal</td>
<td>(28 M X 11M)</td>
</tr>
<tr>
<td>5</td>
<td>Material</td>
<td>Velvet Cloth</td>
</tr>
<tr>
<td>6</td>
<td>Special Feature</td>
<td>Auto Stop, Push Button for forward, reverse, stop</td>
</tr>
</tbody>
</table>

**Rear Stage Curtain**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Items Description</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Type</td>
<td>Horizontal / Vertical Sliding</td>
</tr>
<tr>
<td>2</td>
<td>Motor</td>
<td>1 HP Single phase / three Phase (Geared)</td>
</tr>
<tr>
<td>3</td>
<td>Minimum Overlap</td>
<td>900 mm</td>
</tr>
<tr>
<td>4</td>
<td>Curtain Size Nominal</td>
<td>(24 M X 11M)</td>
</tr>
<tr>
<td>5</td>
<td>Material</td>
<td>Glazed Cotton / Cashmilon</td>
</tr>
<tr>
<td>6</td>
<td>Special Feature</td>
<td>Auto Stop, Push Button for forward, reverse, stop</td>
</tr>
</tbody>
</table>

**Main Side Wings**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Items Description</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mounting</td>
<td>Fixed on Overhead track</td>
</tr>
<tr>
<td>2</td>
<td>Frame</td>
<td>Made of (25 mm X 50 MM) MS pipe</td>
</tr>
<tr>
<td>3</td>
<td>Material</td>
<td>Glazed cotton / Cashmilon</td>
</tr>
</tbody>
</table>

**Frills**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Items Description</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mounting</td>
<td>Mounted on frills bar</td>
</tr>
<tr>
<td>2</td>
<td>Frill Size (Nominal)</td>
<td>(20 M X 2M)</td>
</tr>
<tr>
<td>3</td>
<td>Frill Bar</td>
<td>Made of 32 MM dia pipe</td>
</tr>
<tr>
<td>4</td>
<td>Material</td>
<td>Glazed cotton / Cashmilon</td>
</tr>
</tbody>
</table>

**Cyclorama Screen**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Items Description</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>Specification Item</td>
<td>Detailed Specification</td>
</tr>
<tr>
<td>-----</td>
<td>------------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>Screen size (Nominal)</td>
<td>(9 M X 4.5 M)</td>
</tr>
<tr>
<td>2</td>
<td>Material</td>
<td>High Quality cinematographic material (Matte White)</td>
</tr>
<tr>
<td>3</td>
<td>Frame</td>
<td>Tublar frame 35 mm dia MS pipe</td>
</tr>
</tbody>
</table>

### Video Wall

<table>
<thead>
<tr>
<th>A</th>
<th>Detailed Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group</strong></td>
<td><strong>Specification Item</strong></td>
</tr>
<tr>
<td>System</td>
<td>Display wall</td>
</tr>
<tr>
<td></td>
<td>Display technology</td>
</tr>
<tr>
<td></td>
<td>Display size and resolution</td>
</tr>
<tr>
<td></td>
<td>Combined bezel gap</td>
</tr>
<tr>
<td></td>
<td>Light source</td>
</tr>
<tr>
<td></td>
<td>Brightness</td>
</tr>
<tr>
<td></td>
<td>Color</td>
</tr>
<tr>
<td></td>
<td>Response time</td>
</tr>
<tr>
<td></td>
<td>Viewing angle</td>
</tr>
<tr>
<td></td>
<td>Contrast ratio</td>
</tr>
</tbody>
</table>

#### Signal Interface

<table>
<thead>
<tr>
<th>Interface</th>
<th>Input terminals</th>
<th>Output terminals</th>
<th>User controls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1x Digital DVI-D, 1x Analog RGB, 1x DP, 1x OPS slot</td>
<td>1x Digital DVI-D / DP, 1x Audio Out, 1x Speaker out</td>
<td>Power control: 1 AC power ON/OFF switch</td>
</tr>
<tr>
<td></td>
<td>1x Digital HDMI, 1x Audio (RCA L/R), Stereo mini jack x1</td>
<td>1x RS232C Dsub-9</td>
<td>Wire control: RS232C input</td>
</tr>
<tr>
<td></td>
<td>1x BNC CVBS video, 3x BNC-component</td>
<td>1x RS422 RJ45</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1x RS232C Dsub-9</td>
<td>1x Ethernet RJ45</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1x RS422 RJ45</td>
<td>1x USB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1x BNC CVBS video, 3x BNC-component</td>
<td>1x RS232</td>
<td></td>
</tr>
<tr>
<td><strong>IR remote</strong></td>
<td>IR remote</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>OSD style</strong></td>
<td>list type OSD format</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>On Screen display</strong></td>
<td>Input selection, picture, image and tiling should be adjusted using OSD</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Colour adjustment</strong></td>
<td>User should able to adjust the primary &amp; secondary colours for color alignment and fine tuning</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>OSD Languages</strong></td>
<td>English</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Electrical**

<table>
<thead>
<tr>
<th>AC power input range</th>
<th>90~240VAC, 50/60Hz, 5A max.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power consumption</strong></td>
<td>Normal operating should be $&lt; 150$ W</td>
</tr>
<tr>
<td></td>
<td>Standby mode $&lt; 2$ W at 110VAC</td>
</tr>
</tbody>
</table>

**System Reliability**

<table>
<thead>
<tr>
<th>Operating temperature</th>
<th>0~40°C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operating relative humidity</strong></td>
<td>20~80%</td>
</tr>
<tr>
<td><strong>MTBF</strong></td>
<td>$&gt;= 50,000$ hours</td>
</tr>
</tbody>
</table>

**B CONTROLLER**

<table>
<thead>
<tr>
<th><strong>Group</strong></th>
<th>Specification Item</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Display &amp; Controller</strong></td>
<td>Display &amp; Controller should be from the same manufacturer</td>
</tr>
<tr>
<td><strong>Reputed Company</strong></td>
<td>The OEM should be an established multinational in the field of video walls and should have installations around the world</td>
</tr>
<tr>
<td><strong>Display controller</strong></td>
<td>Separate Controllers to control: (1) 9 displays with 9 DVI outputs, 2 Universal input along with necessary software’s for 3x3 Video Wall (2) 4 displays with 4 DVI outputs, 2 Universal input along with necessary software’s for 2x2 Video Wall</td>
</tr>
<tr>
<td><strong>Chassis</strong></td>
<td>19&quot; industrial Rack mount</td>
</tr>
<tr>
<td></td>
<td>Lockable front door to protect drives</td>
</tr>
<tr>
<td><strong>Operating System Platform</strong></td>
<td>Window 7- 64 bit/Latest Available version</td>
</tr>
<tr>
<td><strong>Processor options</strong></td>
<td>Xeon/ i3/i5/i7</td>
</tr>
<tr>
<td><strong>RAM</strong></td>
<td>Std. 4 GB DDR3, higher on request</td>
</tr>
<tr>
<td><strong>HDD</strong></td>
<td>Support upto minimum 2 HDD</td>
</tr>
<tr>
<td></td>
<td>Std.: 500 GB, can be upgraded on request</td>
</tr>
<tr>
<td>Networking</td>
<td>Dual-port Gigabit Ethernet Controller inbuilt</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Supports Add on copper/ optical fiber adapters</td>
</tr>
<tr>
<td>Input / Output</td>
<td>Serial ATA</td>
</tr>
<tr>
<td>supported</td>
<td>LAN</td>
</tr>
<tr>
<td></td>
<td>* 2x RJ45 LAN ports</td>
</tr>
<tr>
<td></td>
<td>USB 2.0 port</td>
</tr>
<tr>
<td>RAID</td>
<td>RAID 0, 1, 5, 10 support</td>
</tr>
<tr>
<td>Power Supply</td>
<td>(1+1) Redundant hot swappable</td>
</tr>
<tr>
<td>Cooling</td>
<td>Forced cooling</td>
</tr>
<tr>
<td>Indicators</td>
<td>LED's for HDD activity and Power status</td>
</tr>
<tr>
<td>Switches</td>
<td>Power On/Off and System Reset</td>
</tr>
<tr>
<td>Monitoring options</td>
<td>CPU, FAN, Temperature</td>
</tr>
<tr>
<td>Accessories</td>
<td>DVD +RW, Keyboard and mouse</td>
</tr>
<tr>
<td>Voltage</td>
<td>100-240V @ 50/60 Hz</td>
</tr>
<tr>
<td>Redundancy support</td>
<td>Power Supply</td>
</tr>
<tr>
<td></td>
<td>HDD</td>
</tr>
<tr>
<td></td>
<td>Cooling FAN</td>
</tr>
<tr>
<td></td>
<td>LAN ports</td>
</tr>
<tr>
<td>Scalability</td>
<td>Display multiple source windows in any size, anywhere on the wall</td>
</tr>
<tr>
<td>Control functions</td>
<td>Brightness / contrast / saturation/ Hue/ Filtering/ Crop / rotate</td>
</tr>
<tr>
<td>Outputs</td>
<td>9 DVI for 3x3 wall &amp; 4 DVI for 2x2 wall</td>
</tr>
<tr>
<td>Resolution support</td>
<td>DVI: 1920x1200 RGB: 2048x1536</td>
</tr>
<tr>
<td>Universal Inputs</td>
<td>2 Universal input (DVI/ HDMI) for each set of controller</td>
</tr>
<tr>
<td>Accessories</td>
<td>DVD-R,DVD+RW, Keyboard, mouse</td>
</tr>
<tr>
<td>Power Supply</td>
<td>(1 + 1) Redundant AC-DC high-efficiency power supply</td>
</tr>
<tr>
<td></td>
<td>* AC Voltage 100 - 240V, 50-60Hz</td>
</tr>
<tr>
<td>Operating Conditions</td>
<td>* Operating Temperature: 10° to 40°C (50° to 95°F)</td>
</tr>
<tr>
<td></td>
<td>* Non-operating Temperature: -40° to 70°C (-40° to 158°F)</td>
</tr>
<tr>
<td>Feature</td>
<td>Requirements</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Wall management SW</td>
<td>* Humidity: 10 – 90% non-condensing</td>
</tr>
<tr>
<td>Scaling and display</td>
<td>Software tp enable the user to display multiple sources in any size and anywhere on the display wall.</td>
</tr>
<tr>
<td>Auto Source Detection</td>
<td>Software should support for auto source detection</td>
</tr>
<tr>
<td>Layout Management</td>
<td>Should support for Video, RGB, DVI, Internet Explorer, Desktop Application and Remote Desktop Monitoring Layers</td>
</tr>
<tr>
<td>Scenarios</td>
<td>Software should able to Save and Load desktop layouts from Local or remote machines</td>
</tr>
<tr>
<td>Layout Scheduler</td>
<td>All the Layouts can be scheduled as per user convenience</td>
</tr>
<tr>
<td>Layout Preview</td>
<td>Software should support layout preview option</td>
</tr>
<tr>
<td>Launch Application</td>
<td>Software should be able to support</td>
</tr>
<tr>
<td>Integration with 3rd party devices</td>
<td>System should offer interface to enable control from 3rd party devices like Crestron, AMX etc.</td>
</tr>
<tr>
<td>Live Preview</td>
<td>Software should able to provide live preview of videowall</td>
</tr>
<tr>
<td>Work space allocation</td>
<td>System should provide functionality to the administrator to define and allocate work space for a particular operator or a group of operators when working on a Video wall</td>
</tr>
<tr>
<td>Authentication</td>
<td>Software should offer 4 levels of Authentication (User accounts, Permissions for functionality &amp; Roles etc).</td>
</tr>
<tr>
<td>Offline Layouts</td>
<td>It should be possible to create offline layouts</td>
</tr>
<tr>
<td>User friendly</td>
<td>Software should be user friendly</td>
</tr>
<tr>
<td>Ticker</td>
<td>Ticker message can be positioned anywhere on the display wall. Inside the ticker window, font size, colour and background can be set</td>
</tr>
<tr>
<td>Ticker Type</td>
<td>Software should able to prepare three kinds of tickers: text ticker, RSS ticker and time ticker</td>
</tr>
<tr>
<td>SNTP</td>
<td>System should support SNTP function</td>
</tr>
<tr>
<td>Protection</td>
<td>System should have Hardware License key to protect the software from unauthorized access.</td>
</tr>
<tr>
<td>General Requirements</td>
<td>All product must be BIS certified</td>
</tr>
<tr>
<td></td>
<td>Display and controller should be from same OEM to avoid intergration issues during setup or later</td>
</tr>
<tr>
<td>OEM should have service center facility in India</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER – J
TECHNICAL SPECIFICATIONS – SOLAR PV SYSTEM

1. **GENERAL**

This section specifies the Design, engineering, supply, delivery to site, installation, testing, commissioning and maintenance of solar power plant as described in the Content.

1.1. **SOLAR PHOTOVOLTAIC MODULES:**

The total Solar PV minimum array capacity should not be less than 5% of electrical & space conditioning Load and should comprise of poly crystalline modules of minimum 250 Wp and above wattage. The Photovoltaic module must be tested and certified by an independent testing laboratory that is accredited in accordance with ISO Guide 25.

a. The PV modules should be of Indigenous make. The PV modules must conform to the latest edition of any of the following / equivalent BIS standards for PV module design qualification and type approval:

- Crystalline Silicon Terrestrial PV Modules IEC 61215 / IS14286
- In addition, the modules must conform to IEC 61730 Part 1 (requirements for Construction) & Part 2 (requirements for testing, for safety qualification).
- Further, the PV modules must also qualify the Salt Mist Corrosion Testing as per IEC61701 / IS 61701

b. SPV module Conversion efficiency should be equal to or greater than 14% at STC and AM 1.5 radiations.

c. The PV modules shall perform satisfactorily in humidity up to 100 % with temperature between -40°C to +85°C. Since the modules would be used in a high voltage circuit, the high voltage insulation test shall be carried out on each module and a test certificate to that effect be provided.

e. Other general requirement for the PV modules and subsystems shall be the following:

i. Solar cells technology employed in the module production shall have to be certified and a certificate giving details of major materials i.e. cells, Glass, back sheet, their makes and data sheets to be submitted.

ii. The rated output power of any supplied module shall not have negative tolerance.

iii. The peak-power point voltage and the peak-power point current of any supplied module and/or any module string (series connected modules) shall not vary more than 3 (three) percent from the respective arithmetic means for all modules and/or for all module string, as the case may be

iv. Except where specified, the front module surface shall consist of impact resistant, low-iron and high-transmission toughened glass.

v. The module frame, if any, shall be made of aluminum or corrosion-resistant material which shall be electrolytically compatible with the structural material used for mounting the modules.

vi. The module shall be provided with a junction box with either provision of external screw terminal connection or sealed type and with arrangement for provision of by-pass diode. The box shall have hinged, weather proof lid with captive screws and cable gland entry points or may be of sealed type IP65 rated.
vii. Necessary I-V curves at 250 C, 450,600 and at NOC are required to be furnished.

viii. Fill factor of module shall not be less than 0.70

1.2. ARRAY STRUCTURE:

a. The array structure shall be so designed that it will occupy minimum space without scarifying the output from SPV panels.

b. Structural material shall be corrosion resistant and electrotyically compatible with the material used in the module frame, its fasteners, nuts and bolts. Galvanizing should meet ASTM A-123 hot dipped galvanizing or equivalent which provides at least spraying thickness of 70 micron on steel as per IS 5905.

c. Structures shall be supplied complete with all members to be compatible for allowing easy installation at the roof top site and the structure atop sloping roofs shall be done by the Bidder.

d. Each structure shall have a provision to adjust its angle of inclination to the horizontal as per the site conditions.

e. The array structure shall be grounded properly using maintenance free earthing kit.

f. Each panel frame structure should be so fabricated as to be fixed on the rooftop column/wall structures. The structure should be capable of withstanding a wind load of 200 km/hr. after grouting & installation. The front end of the solar array must be one meter above the rooftop. Grouting material for SPV structures shall be as per M15 (1:2:4) concrete specifications.

g. The supplier shall specify installation details of the PV modules and the support structures with appropriate diagrams and drawings. Such details shall include, the following:

i. Determination of true south at the site;

ii. Array tilt angle to the horizontal, with permitted tolerance;

iii. Details with drawings for fixing the modules;

iv. Details with drawings of fixing the junction/terminal boxes;

v. Interconnections details inside the junction/terminal boxes;

vi. Structural installation details and drawings;

vii. Electrical earthing;

viii. Inter-panel/inter-row distance with allowed tolerances; and

ix. Safety precautions to be taken.

k. The array structure shall support SPV modules at a given orientation and absorb and transfer the mechanical loads to the rooftop columns properly. All nuts and bolts shall be of very good quality stainless steel. Detailed design and drawing shall have to be submitted for acceptance and approval before execution of work.

1.3. POWER CONDITIONING UNIT (PCU)

The PCU required of appropriate capacities as follows, should convert DC power produced by SPV modules, in to AC power and adjust the voltage & frequency levels to suit the local grid conditions.

PCU should be appropriate capacity of proposed solar PV plants

1.4. POWER CONDITIONING UNIT (INVERTER PLUS MPPT CHARGE CONTROLLER)

Input Voltage:
• From PV Module: Minimum 08KWp, 120V nominal DC from Solar PV Array.
• From AC source 415V, 3 ph, 50 Hz

Output Voltage:

Suitable for charging 120 V, 600AH tubular plate lead acid VRLA Gel type battery bank.

Protection:
• Short Circuit
• Deep discharge
• Over charging (Automatic trickle charge mode on full charge)
• Input surge voltage
• Over current (Load)
• Battery reverse polarity
• Solar Array reverse polarity

Indication (LED/LCD Indication):
• String on
• Mains on
• Input on
• Control on
• Charge on
• 80% charged, 100% charged
• Charger overload
• Battery on trickle
• Battery disconnected/fault battery reverse polarity
• Low solar power
• System fault
• Charger over temperature
• Input over/under voltage (for AC)

Operating Temp: 0-50 Deg C
Humidity: 0-95% non condensing
Enclosure IP 32
No Load Consumption: < 1%

1.5. INVERTER:

1.5.1. Common Technical Specification:
• Control Type : Voltage source, microprocessor assisted, output regulation
• Output Voltage : 3 phase, 415 Volt AC
• Frequency : 50 Hz
• DC link voltage range : 0 to 800 V
• Total Harmonic Distortion - less than 3%
• Maximum current ripple - 4% PP
• Reactive Power - 0.95 inductive to 0.95 capacitive
• Operating Temp. Range - 5 deg C to 55 deg C
• Housing Cabinet - INVERTER to be housed in suitable switch cabinet, Within IP 65 Degree of ingress protection for outdoor and IP 20 for Indoor.
• Inverter efficiency - 95% and above at full load,
• Power Control - MPPT

1.5.2. Other important Features/Protections required in the INVERTER

• Mains (Grid) over-under voltage and frequency protection
• Array ground fault detection
• Automatic fault conditions reset for all parameter like voltage, frequency and/or black out.
• MOV type surge arrester on AC and DC terminals for over voltage protection from lightening-induced surges.
• INVERTER should be rated to operate at 0-55 deg. centigrade unless provision for air conditioning is included in INVERTER
• Overload capacity (for 10 sec) should be 150% of continuous rating.
• PCU shall be capable to synchronize independently & automatically/to be phase locked with Power Supply Authority grid power line frequency to attain synchronization & export power generated by the solar panel to Power Supply Authority grid.
• The DC to AC conversion efficiency shall at least be 95percent at full load. The idling current at no load must not exceed 2 percent of the full load current.
• Transformer less inverters shall be preferred. Restriction of DC components on AC side shall be achieved.
• The INVERTER shall be capable of operating in parallel with the grid utility service and shall be capable of interrupting line-to-line fault currents and line-to-ground fault currents.
• The INVERTER shall be able to withstand an unbalance output load to the extent of 30%.
• The INVERTER shall include appropriate self-protective and self-diagnostic features to protect itself and the PV array damage in the event of INVERTER component failure or from parameters beyond the INVERTER’s safe operating range due to internal or external causes. The self-protective features shall not allow signals from the INVERTER front panel to cause the INVERTER to be operated in a manner which may be unsafe or damaging. Faults due to malfunctioning within the INVERTER, including commutation failure, shall be cleared by the inverter protective devices and not by the existing site utility grid service circuit breaker.
• The INVERTER shall go to shut down/standby mode, with its contacts open, under the following conditions before attempting an automatic restart after an appropriate time delay;
(i) **Insufficient Solar Power Input**

When the solar available from the PV array is insufficient to supply the losses of the INVERTER, the INVERTER shall go to a standby/shutdown mode. The INVERTER control shall prevent excessive cycling during rightly shut down or extended periods of insufficient solar radiation.

(ii) **Utility-Grid Over or Under Voltage**

The INVERTER shall restart after an over or under voltage shutdown where the utility grid voltage has returned to within limits for a minimum of two minutes.

(iii) **Utility-Grid Over or Under Frequency**

The INVERTER shall restart after an over or under frequency shutdown when the utility grid voltage has returned to within limits for minimum of two minutes.

- The INVERTER generated harmonics measured at the point of connection to the utility services when operating at the rated power shall not exceed a total harmonics current distortion of 3 percent, a single frequency current distortion of 4 percent and single frequency voltage distortion of 1 percent, when the first through the fiftieth integer harmonics of 50 Hz are considered.
- The INVERTER power factor at the point of utility services connection shall be 0.95 lagging or leading when operating at above 25 percent of the rated output.
- The internal copper wiring of the INVERTER shall have flame resistant insulation. Use of PVC is not acceptable. All conductors shall be made of standard copper.
- Full protection against accidental open circuit and reverse polarity at the input shall be provided.
- The INVERTER shall have an appropriate display on the front panel to display the instantaneous AC power output and the DC voltage, current and power input. Each of these measurements displays shall have an accuracy of 1 Percent of full scale or better.
- The Inverter shall be with Bi-directional full sine wave charge controller 120 V DC output.
- Electrical safety, Earthing and Protections shall be as per CPWD specifications for Electrical works Part I- 2013.

1.6. **Factory testing**

a. The INVERTER shall be tested to demonstrate operation of its control system and the ability to be automatically synchronized and connected in parallel with a utility service, prior to its shipment.

b. Factory testing shall not only be limited to measurement of phase currents, efficiencies, harmonics content and power factor, but shall also include all other necessary tests/simulations required and requested by the Purchasers Engineers. Tests may be performed at 25, 50, 75 and 100 percent of the rated nominal power.

c. A factory Test Reports (FTR) shall be supplied with the unit after all tests. The FTR shall include detailed description of all parameters tested qualified and warranted.

1.7. **Operating modes:**

Operational or MPP tracking mode: The control system continuously adjust the voltage of the generator to optimize the power available. The power conditioner must automatically re-enter stand-by mode when input power reduces below the standby mode threshold.
Front Panel display should prove the status of the INVERTER, including AC Voltage, Current, Power output & DC Current, Voltage and Power input, pf and fault Indication (if any)

1.8. Codes and standards:

The quality of equipment supplied shall be controlled to meet codes listed in relevant ISI and other standards, such as:

- IEEE 928 Recommended Criteria for Terrestrial PV Power systems.
- IEEE 519 guide for Harmonic Control and Reactive Compensation of Static Power Controllers.
- National Electrical NEPA 70-(USA) or equivalent national standard.
- National Electrical safety Code ANSI C2-(USA) or equivalent national standard.
- JRC Specification 503 (Version 2.2 March 1991) or JPL Block V standard for PV modules.

1.9. Plant metering/data logging

a. PV array energy production: Digital Meters to log the actual value of AC/DC Voltage, Current & Energy generated by the PV systems shall have to be provided. 1 Nos. two way LT 415V energy meters (import – export) class 0.2S ABT compliant shall be incorporated in the system one for each Solar PV Plant.

b. Data logging systems(Hardware and software) one for each Solar PV Plant, for plant control and monitoring shall be provided with the following features suitable Computers: Desktop Computer 3 GHz Pentium i7 latest (3MB Cache) with 500 GB HDD, 4 GB RD RAM, 2 Parallel & 2 Serial Port, Wi-Fi Lan Card, DVD RW Drive, 20” LED Display, USB Scroll Mouse, along with All in one 1200 dpi/12 ppm Desktop LaserJet printers along with a 1 KVA on-line ups with 1 hour battery backup.

c. Remote Supervisory Control and data acquisition through SCADA software at the purchaser location through Handheld device /GSM cellular device with latest software/hardware configuration and service connectivity for online/real time data monitoring/control complete to be supplied and operation and maintenance /control to be ensured by the supplier.

d. All major parameters should be available on the digital bus and logging facility for energy auditing through the internal microprocessor and can be read on the digital LCD/LED front panel at any time the current values, previous values for up to a month and the average values. The following parameters should be accessible via the operating interface display:

- AC Voltage
- AC Output current
- Output Power
- DC Input Voltage
- DC Input Current
- Time Active
- Time disabled
- Time Idle
- Temperatures (C)
• Inverter Status

1.10. **Disconnection and islanding**

Disconnection of the PV generator in the event of loss of the main grid supply is to be achieved by in built protection within the power conditioner. This may be achieved through rate of change of current, phase angle, unbalanced voltage or reactive load variants. Operation outside the limits of power quality as described in the technical data sheet should cause the power conditioner to disconnect the grid. Additional parameters requiring automatic disconnection are:

- Neutral voltage displacement
- Over current
- Earth fault
- Reverse power

In case of the above, tripping time should be less than 0.5 seconds. Response time in case of grid failure due to switch off or failure based shut down should be well within 5 seconds.

Automatic re - connection after the grid failure is restored

INVERTER shall have facility to reconnect the Inverter automatically to the grid following restoration of grid, subsequent to grid failure condition. The system should have integrated SCADA and software or plant control and remote communication with web monitoring to monitoring individual strings and complete power plant.

1.11. **ARRAY JUNCTION BOX, MAIN JUNCTION BOXES WITH STRING MONITORING FEATURE TO THE INVERTER:**

The junction boxes are to be provided in the PV yard for termination of connecting cables. The Junction Boxes shall be made of FRP/Powder Coated Aluminum with full dust, water & vermin proof arrangement. All wires/cables must be terminated through cable lugs. The JBs shall be such that input & output termination can be made through suitable cable glands.

- Copper bus bars/terminal blocks housed in the junction box with suitable termination
- Threads
- Conforming to IP65 (for outdoor)/ IP 21 (for indoor) standards and IEC 62208
- Hinged door with EPDM rubber gasket to prevent water entry.
- Single compression cable glands.
- Provision capacity MOVs provided within the box to protect against lightening.

1.12. **ENERGY METER**

A 3 Phase, 20-60 A Energy Meter shall be provided as approved by Engineer-in-charge to measure the quantum of energy. Meter must be provided with the necessary data cables. Energy Meter should be 0.5 Class of accuracy.

1.13. **DC DISTRIBUTION BOARD:**

Each Solar PV Plant shall have its separate DC Distribution panel to receive the DC output from the array field with analog measurement meter for voltage, current and power from different MJBs so as to check any failure in the array field.
DCDBs shall be dust & vermin proof. The bus bars are to be made of copper of desired size. Suitable capacity MCBS/MCCBs to be provided for controlling the DC power output to the INVERTER along with necessary surge arrestors.

1.14. **AC DISTRIBUTION PANEL BOARD**

Each plant shall be supplied with its dedicated AC Distribution panel which shall be located at an appropriate location in the building itself. ACDBs are to be provided at the cable terminating points emanating from the inverters. The AC power from inverter of each individual Solar PV Plant shall be fed into its dedicated AC Distribution panel. Thereafter, the outputs shall be terminated into the main LT supply.

AC Distribution Panel Board (DPB) shall control the AC power from inverter and should have necessary surge arresters. Interconnection from ACDB to mains at LT bus bar is to be carried out and complete equipment along with metering to be installed in the ACDB.

Panel type: Wall mounting type & CRCA 2.5 mm thick with IP 32 protection Cable Gland suitable to Incoming & out going cable

1.15. **SOLAR CABLES:**

- Solar cables of suitable size & cross section shall be provided for the interconnection purpose in photovoltaic power generation. Solar cables shall interconnect solar panels and other electrical components of the photovoltaic system. Solar cables shall be UV resistant and weather resistant. Solar cables shall withstand a large temperature range from -40°C to +90°C ambient and shall be generally laid outside.

- Solar cables shall be Tinned Copper XLPO insulated & LSZH sheathed suitable for 1100 VAC/ 1800 VDC.

- All cable tests and methods should confirm to IEC 60189 or other relevant standards.

- Cabling in the yard shall be carried out as per IE rules. All other cabling above ground should be suitably mounted on cable trays with proper covers.

- The size of cable for connecting module to terminal box, terminal box to panel junction box, panel junction box to array junction box and array junction box to PCU to Battery Bank/ACDB shall be as per site requirement. The decision of Engineer-in-charge shall be final.

- Cables ends: All connections are to be made through suitable cable/lug/terminals; crimped properly & with use of cable glands.

- Multi Strand, Annealed high conductivity copper conductor

- PVC type ‘A’ pressure extruded insulation

- Overall PVC insulation for UV protection and confirm to IEC 69947.

- Armored cable for underground laying

- Selected cable should carry a current density of minimum 1.2 Amp/Sq.mm

- All electrical/wires inside the building to be fixed in Rigid Steel Conduit for wiring inside the building.

- The cable’s insulation must be able to withstand thermal and mechanical loads.

- The insulation and jacket materials shall be extremely resistant to weathering, UV-radiation and abrasion. Additionally, solar cables shall be salt water resistant and resistant to acids and alkaline solutions. Solar cables shall be suitable for fixed installation as well as for
moving applications without tensile load. These solar cables shall be especially designed for outdoor use for withstanding direct sun radiation and air humidity. Cables should be halogen free flame retardant and made of cross-linked jacket material. The solar cables shall also be installed in dry and humid conditions indoors.

- For laying/termination of cables, latest BIS/IEC codes/standards to be followed.

1.16. FIRE EXTINGUISHERS:

- The firefighting system for the fire protection of solar power plants shall be consisting of:
- CO2 type 4.5 kg fire extinguishers in the control room for fire caused by electrical short circuits.
- Sand buckets in the control room. The installation of fire Extinguishers should confirm to TAC regulations and BIS standards. The fire extinguishers shall be provided in the control room housing the batteries and PCUs.

1.17. LIGHTENING PROTECTION

There shall be required number of suitable lightening arrestors installed in the array field.

1.17.1. EARTHING PROTECTION

Each array structure of the PV yard should be grounded properly. In addition the lightening arrester/masts should also be provided inside the array field. Provision should be kept for shorting and grounding of the PV array at the time of maintenance work. All metal casing/shielding of plant should be thoroughly grounded in accordance with Indian Electricity Act./IE Rules. Earth resistance should be tested in presence of the representative of Engineer In Charge.

1.17.2. DANGER BOARDS

Danger board should be provided as and where necessary as per IE act/IE rules as amended up to date.

**IMPORTANT INDIAN STANDARDS**

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Standard</th>
<th>Title</th>
<th>Reaffirm Date</th>
<th>Amdt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3)</td>
<td>IS 8061:1976</td>
<td>Code of practice for design, installation and maintenance of service lines upto and including 650 V</td>
<td>March 2011</td>
<td></td>
</tr>
<tr>
<td>(4)</td>
<td>IS 8884:1978</td>
<td>Code of practice for the installation of electric bells and call systems</td>
<td>August 2012</td>
<td></td>
</tr>
<tr>
<td>(6)</td>
<td>IS 11353:1985/</td>
<td>Guide for uniform system of marking and identification</td>
<td>July 2012</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Standard Code</td>
<td>Description</td>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-----------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>------------</td>
<td></td>
</tr>
<tr>
<td>(7)</td>
<td>IEC 60445 (1973)</td>
<td>Conductors and apparatus terminals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(13)</td>
<td>IS 4347:1967</td>
<td>Code of practice for hospital lighting</td>
<td>May 2010</td>
<td></td>
</tr>
<tr>
<td>(14)</td>
<td>IS 6665:1972</td>
<td>Code of practice for industrial lighting</td>
<td>May 2010</td>
<td></td>
</tr>
<tr>
<td>(15)</td>
<td>IS 2672:1966</td>
<td>Code of practice for library lighting</td>
<td>May 2010</td>
<td></td>
</tr>
<tr>
<td>(20)</td>
<td>IS 4146:1983</td>
<td>Application guide for voltage transformers (first revision)</td>
<td>September 2011</td>
<td></td>
</tr>
<tr>
<td>(21)</td>
<td>IS 4201:1983</td>
<td>Application guide for current transformers (first revision)</td>
<td>September 2011</td>
<td></td>
</tr>
<tr>
<td>(22)</td>
<td>IS 5547:1983</td>
<td>Application guide for capacitor voltage transformers (first revision)</td>
<td>September 2011</td>
<td></td>
</tr>
</tbody>
</table>
(22) IS 2309:1989 Code of practice for protection of buildings and allied structures against lightning (second revision) March 2010 1

### ELECTRIC FANS

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Standard</th>
<th>Title</th>
<th>Reaffirm Date</th>
<th>Amdt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>IS 555:1979</td>
<td>Electric table type fans and regulators (third revision)</td>
<td>July 2010</td>
<td>2</td>
</tr>
<tr>
<td>(2)</td>
<td>IS 1169:1967</td>
<td>Electric pedestal type fans and regulators (first revision)</td>
<td>Mar 2009</td>
<td>6</td>
</tr>
<tr>
<td>(3)</td>
<td>IS 374:1979</td>
<td>Electric ceiling type fans and regulators (third revision)</td>
<td>September 2010</td>
<td>6</td>
</tr>
<tr>
<td>(4)</td>
<td>IS 2997:1964</td>
<td>Air circulator type electric fans and regulators</td>
<td>July 2010</td>
<td>8</td>
</tr>
<tr>
<td>(6)</td>
<td>IS 3588:1987</td>
<td>Electric axial flow fans (first revision)</td>
<td>August 2009</td>
<td>1</td>
</tr>
<tr>
<td>(7)</td>
<td>IS 3963:1987</td>
<td>Roof extractor units (first revision)</td>
<td>August 2009</td>
<td>3</td>
</tr>
<tr>
<td>(8)</td>
<td>IS 4283:1981</td>
<td>Hot air fans (first revision)</td>
<td>August 2009</td>
<td>3</td>
</tr>
<tr>
<td>(9)</td>
<td>IS 6272:1987</td>
<td>Industrial cooling fans (man coolers) (first revision)</td>
<td>August 2009</td>
<td>2</td>
</tr>
<tr>
<td>(10)</td>
<td>IS 4894:1987</td>
<td>Centrifugal fans (first revision)</td>
<td>August 2009</td>
<td>3</td>
</tr>
<tr>
<td>(11)</td>
<td>IS 11037:1984</td>
<td>Electronic type fan regulators</td>
<td>August 2010</td>
<td>3</td>
</tr>
<tr>
<td>(12)</td>
<td>IS 12155:1987</td>
<td>General and safety requirements for fans and regulators for household and similar purposes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### LOW VOLTAGE SWITCH GEAR AND CONTROL GEAR

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Standard</th>
<th>Title</th>
<th>Reaffirm Date</th>
<th>Amdt.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sl.No.</td>
<td>Standard</td>
<td>Title</td>
<td>Reaffirm Date</td>
<td>Amdt.</td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>---------------</td>
<td>-------</td>
</tr>
<tr>
<td>(1)</td>
<td>IS 4237:1982</td>
<td>General requirements for switchgear and controlgear for voltages not exceeding 1000 volts ac or 1200 volts dc (first revision) [superseded by IS 13947 (Part 1):1993]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2)</td>
<td>IS 6875 (Part 1): 1973</td>
<td>Control switches (switching devices for control and auxiliary circuits including contactor relays) for voltages upto and including 1000 V ac &amp; 1200 V dc: Part 1 General requirements [superseded by IS 13947 (Part 5/Section 1)]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3)</td>
<td>IS 6875 (Part 2): 1973</td>
<td>Control switches (switching devices for control and auxiliary circuits including contactor relays) for voltages upto and including 1000 V ac and 1200 V dc: Part 2 Push-buttons and related control switches [Superseded by IS 13947 (Part 5/Section 1)]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4)</td>
<td>IS 6875 (Part 3): 1980</td>
<td>Control switches (switching devices for control and auxiliary circuits including contactor relays) for voltages upto and including 1000 V ac and 1200 V dc: Part 3 Rotary control switches [superseded by IS 13947 (Part 5/Section 1)]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5)</td>
<td>IS 10027:2000</td>
<td>Composite units of air-break switches and rewirable type fuses for voltages not exceeding 650 volt ac - Specification (first revision)</td>
<td>March 2010</td>
<td></td>
</tr>
<tr>
<td>(7)</td>
<td>IS 2675:1983</td>
<td>Enclosed Distribution Fuse Boards and Cut Outs for voltages not exceeding 1000 V A.C. or 1200 V D.C.</td>
<td>March 2011</td>
<td></td>
</tr>
<tr>
<td>(8)</td>
<td>IS 8828:1996</td>
<td>Circuit-breakers for over current protection for household and similar installations (second revision)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(9)</td>
<td>IS 13032:1991</td>
<td>Miniature circuit breaker boards for voltage upto and including 1 000 Volt ac</td>
<td>March 2011</td>
<td>1</td>
</tr>
<tr>
<td>Sl.No.</td>
<td>Standard</td>
<td>Title</td>
<td>Reaffirm Date</td>
<td>Amdt.</td>
</tr>
<tr>
<td>-------</td>
<td>----------</td>
<td>-------</td>
<td>---------------</td>
<td>-------</td>
</tr>
<tr>
<td>(10)</td>
<td>IS 12640 (Part 1): 2008</td>
<td>Residual current operated circuit-breakers for household and similar uses: Part 1 circuit-breakers without integral over current protection (RCCBs) (First Revision)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(11)</td>
<td>IS 12640 (Part 2): 2008</td>
<td>Residual current operated circuit-breakers for household and similar uses: Part 2 circuit breakers with integral over current protection (RCBOs) (First Revision)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(12)</td>
<td>IS 2959:1985</td>
<td>Contactors for voltages not exceeding 1000 V ac or 1200 V dc (first revision) [superseded by IS 13947 (Part 4/Section 1)]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(13)</td>
<td>IS 12021:1987</td>
<td>Specification for control transformers for switchgear and controlgear for voltages not exceeding 1000 Volt AC</td>
<td>March 2010</td>
<td>2</td>
</tr>
<tr>
<td>(14)</td>
<td>IS 5039:1983</td>
<td>Distribution pillars for voltages not exceeding 1000 volts (first revision)</td>
<td>March 2011</td>
<td>2</td>
</tr>
<tr>
<td>(19)</td>
<td>IS 8544 (Part 3/Sec 1): 1979</td>
<td>Motor starters for voltages not exceeding 1000 V: Part 3 Rheostatic motor starters, Section 1 General requirements [superseded by IS 13947 (Part 4/Section 1): 1993]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Motor starters for voltages not exceeding 1000 V; Reduced voltage ac starters: two step auto-transformer starters [superseded by IS 13947 (Part 4/Section 1): 1993]

**POWER CABLE**

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Standard</th>
<th>Title</th>
<th>Reaffirm Date</th>
<th>Amdt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>IS 694:1990/IEC 60227-1 to 5 (1979)</td>
<td>PVC Insulated cables for working voltages upto and including 1100 V</td>
<td>February 2010</td>
<td>5</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 upto and including 450/750 V: Part 1 General requirements (fourth revision)</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>(3)</td>
<td>IS 1554 (Part 1): 1988/IEC 60502 (1983)</td>
<td>PVC insulated (heavy duty) electric cables: Part 2 For working voltages upto and including 1100 V (Third revision)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5)</td>
<td>IS 4288:1988</td>
<td>PVC insulated (heavy duty) electric cables with solid aluminium conductors for voltages upto and including 1100 V (second revision) (withdrawn)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ELECTRIC WIRING ACCESSORIES**

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Standard</th>
<th>Title</th>
<th>Reaffirm Date</th>
<th>Amdt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3)</td>
<td>IS 3480:1966</td>
<td>Flexible steel conduits for electrical wiring</td>
<td>May 2012</td>
<td>(1)</td>
</tr>
<tr>
<td>Sl.No.</td>
<td>Standard</td>
<td>Title</td>
<td>Reaffirm Date</td>
<td>Amdt.</td>
</tr>
<tr>
<td>-------</td>
<td>----------</td>
<td>-------</td>
<td>---------------</td>
<td>-------</td>
</tr>
<tr>
<td>(5)</td>
<td>IS 3837:1976</td>
<td>Accessories for rigid steel conduits for electrical wiring (first revision)</td>
<td>May 2012</td>
<td>(1)</td>
</tr>
<tr>
<td>(8)</td>
<td>IS 3419:1989</td>
<td>Fittings for rigid non-metallic conduits (second revision)</td>
<td>May 2012</td>
<td></td>
</tr>
<tr>
<td>(9)</td>
<td>IS 14772:2000/IEC 60670-1 (1989)</td>
<td>Enclosures for accessories for household and similar fixed electrical installations [Superseding IS 5133 (Part 1 and 2)]</td>
<td>May 2010</td>
<td></td>
</tr>
<tr>
<td>(10)</td>
<td>IS 2412:1975</td>
<td>Link clips for electrical wiring (first revision)</td>
<td>May 2012</td>
<td>(2)</td>
</tr>
<tr>
<td>(11)</td>
<td>IS 371:1999</td>
<td>Ceiling roses (third revision)</td>
<td>March 2010</td>
<td>(4)</td>
</tr>
<tr>
<td>(13)</td>
<td>IS 4615:1968</td>
<td>Switch-socket outlets (non-interlocking type) (Withdrawn)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CODES OF PRACTICE GUIDE**

**ELECTRICAL LAMPS AND THEIR AUXILIARIES**
### High pressure mercury vapour lamps: Part 1 Requirements and test
(October 2012)

- IS 9900 (Part 1):
  - 1981
  - IEC 188 (1974)

- IS 9974 (Part 1):
  - 1981
  - IEC 662 (1980)

### High pressure sodium vapour lamps: Part 1 General requirements and tests
(October 2012)

- IS 1258:2005:
  - IEC 61184 (1997)

### Bi-pin lamp holders for tubular fluorescent lamps
(October 2012)

- IS 3323:1980:
  - IEC 60400 (1972)

### Bi-pin lamp holders for tubular fluorescent lamps
(October 2012)

- IS 3324:1982:
  - IEC 400 (1972)

### Starters for fluorescent lamps (third revision)
(Jun 2010)

- IS 2215:2006:
  - IEC 60155 (1993)

### Ballasts for fluorescent lamps: Part 1 For switch start circuits (second revision)
(July 2011)

- IS 1534 (Part 1):
  - 1977
  - IEC 82 (1973)

### Capacitors for use in tubular fluorescent lamps
(July 2011)

- IS 1569:1976:
  - IEC 566

### Ballasts for high pressure mercury vapour lamps
(First revision)

- IS 6616:1982:
  - IEC 262 (1969)

---

**CODES OF PRACTICE GUIDE**

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Standard</th>
<th>Title</th>
<th>Reaffirm Date</th>
<th>Amdt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>IS 1913 (Part 1): 1978</td>
<td>General and safety requirements for luminaires: Part 1 Tubular fluorescent lamps (second revision)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3)</td>
<td>IS 10322 (Part 1)</td>
<td>Luminaires: Part 1 Constructional Requirements</td>
<td>May 2010</td>
<td></td>
</tr>
</tbody>
</table>
### CODES OF PRACTICE GUIDE

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Standard</th>
<th>Title</th>
<th>Reaffirm Date</th>
<th>Amdt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(4)</td>
<td>IS 10322 (Part 5/ Sec. 2):2012</td>
<td>Luminaires: Part 5 Particular requirements, Sec 2 Recessed luminaires (First Revision)</td>
<td>March 2012</td>
<td></td>
</tr>
<tr>
<td>(5)</td>
<td>IS 10322 (Part 5/ Sec. 3):2012/ IEC 60598-2-3 (1979)</td>
<td>Luminaires: Part 5 Particular requirements, Sec 3 Luminaires for road and street lighting (First revision)</td>
<td>March 2012</td>
<td></td>
</tr>
<tr>
<td>(8)</td>
<td>IS 3287:1965</td>
<td>Industrial lighting fittings with plastic reflectors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(9)</td>
<td>IS 1777:1978</td>
<td>Industrial luminaires with metal reflectors (first revision)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(10)</td>
<td>IS 2206 (Part 1):1984</td>
<td>Flameproof electric lighting fittings: Part 1 Well-glass and bulkhead types (first revision)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(11)</td>
<td>IS 3528:1966</td>
<td>Waterproof electric lighting fittings</td>
<td>May 2010</td>
<td></td>
</tr>
<tr>
<td>(12)</td>
<td>IS 3553:1966</td>
<td>Watertight electric lighting fittings</td>
<td>May 2010</td>
<td></td>
</tr>
<tr>
<td>(14)</td>
<td>IS 7537:1974</td>
<td>Road traffic signals</td>
<td>March 2008</td>
<td></td>
</tr>
</tbody>
</table>

### ELECTRICAL APPLIANCES

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Standard</th>
<th>Title</th>
<th>Reaffirm Date</th>
<th>Amdt.</th>
</tr>
</thead>
</table>

---

Tender No. HITES/AIIMS-Guwahati/2018  
Page 393
<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Standard</th>
<th>Title</th>
<th>Reaffirm Date</th>
<th>Amdt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2)</td>
<td>IS 2268:1994</td>
<td>Electric call bells and buzzers for indoor use (second revision)</td>
<td>March 2009</td>
<td></td>
</tr>
<tr>
<td>(3)</td>
<td>IS 3412:1994</td>
<td>Electric water boilers (second revision)</td>
<td>March 2009</td>
<td></td>
</tr>
</tbody>
</table>

### ELECTRICAL INSTRUMENTS

#### CODES OF PRACTICE GUIDE

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Standard</th>
<th>Title</th>
<th>Reaffirm Date</th>
<th>Amdt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>IS 6236:1971/ IEC 60258 (1968)</td>
<td>Direct recording electrical measuring Instruments</td>
<td>January 2010</td>
<td></td>
</tr>
<tr>
<td>(7)</td>
<td>IS 722(Part 1): 1998</td>
<td>AC electricity meters : General requirement and tests</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Standard</td>
<td>Title</td>
<td>Reaffirm Date</td>
<td>Amdt.</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------------------------</td>
<td>-----------------------------------------------------------------------</td>
<td>---------------</td>
<td>-------</td>
</tr>
<tr>
<td>10</td>
<td>IS 722 (Part 5): 1980</td>
<td>AC electricity meters: Part 5 Volt-ampere hour meters for restricted power factor range, class 3.5 (first revision)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>IS 722 (Part 7/Sec 1): 1987</td>
<td>AC electricity meters: Part 7 Volt-ampere hour meters for full power factor range, Section 1 General requirements (first revision)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>IS 722 (Part 8): 1972</td>
<td>AC electricity meters: Part 8 Single-phase 2-wire whole current watt-hour meter (class 1.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>IS 722 (Part 9): 1972</td>
<td>AC electricity meters: Part 9 Three-phase whole current and transformer operated watt-hour meters and single-phase two-wire transformer operated watt-hour meters (class 1.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>IS 8530: 1977</td>
<td>Maximum demand indicators (class 1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>*IS 2992:1987</td>
<td>Insulation resistance testers, hand operated (magneto generator type) (second revision)</td>
<td>Jan 2010</td>
<td></td>
</tr>
</tbody>
</table>

### INSTRUMENT TRANSFORMERS

#### CODES OF PRACTICE GUIDE

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Standard</th>
<th>Title</th>
<th>Reaffirm Date</th>
<th>Amdt.</th>
</tr>
</thead>
</table>
### IEC 60185 (1966)

  - Current transformers: Part 4 Protective current transformers for special purpose applications (second revision)
  - Aug 2012

- **(5)** IS 6949:1973
  - Summation current transformers
  - Sep 2011

### FUSES

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Standard</th>
<th>Title</th>
<th>Reaffirm Date</th>
<th>Amdt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2)</td>
<td>IS 9224 (Part 2): 1979</td>
<td>Low voltage fuses: Part 2 Supplementary requirements for fuses for industrial applications (superseding IS 2208) [superseded by IS 13703 (part 2/Section 1):1993]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3)</td>
<td>IS 2086:1993</td>
<td>Carriers and bases used in rewirable type electric fuses for voltages upto 650 V (third revision) [Superseding IS 8724]</td>
<td>Mar 2009</td>
<td>(1)</td>
</tr>
<tr>
<td>(4)</td>
<td>IS 9926:1981</td>
<td>Fuse wires used in rewirable type electric fuses upto 650 volts</td>
<td>Mar 2011</td>
<td></td>
</tr>
<tr>
<td>(5)</td>
<td>IS 8187:1976/IEC 269-3 (1973)</td>
<td>D-type fuses</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### MISCELLANEOUS

#### ELECTROTECHNICAL VOCABULARY

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Standard</th>
<th>Title</th>
<th>Reaffirm Date</th>
<th>Amdt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>IS 2551:1982</td>
<td>Danger notice plates (first revision)</td>
<td>Mar 2010</td>
<td></td>
</tr>
<tr>
<td>Sl.No.</td>
<td>Standard</td>
<td>Title</td>
<td>Reaffirm Date</td>
<td>Amdt.</td>
</tr>
<tr>
<td>-------</td>
<td>----------</td>
<td>-------</td>
<td>---------------</td>
<td>-------</td>
</tr>
<tr>
<td>(4)</td>
<td>IS 1885 (Part 16/Sec 1):1968</td>
<td>Electrotechnical vocabulary: Part 16 Lighting, Section 1 General aspects</td>
<td>Jul 2012</td>
<td></td>
</tr>
<tr>
<td>(5)</td>
<td>IS 1885 (Part 16/Sec 2):1968</td>
<td>Electrotechnical vocabulary: Part 16 Lighting, Section 2 General illumination, lighting fittings and lighting for traffic and signaling</td>
<td>Jul 2012</td>
<td></td>
</tr>
<tr>
<td>(6)</td>
<td>IS 1885 (Part 16/Sec 3):1967</td>
<td>Electrotechnical vocabulary: Part 16 Lighting, Section 3 Lamps and auxiliary apparatus</td>
<td>Jul 2012</td>
<td></td>
</tr>
</tbody>
</table>

**SAFETY**

**CODES OF PRACTICE GUIDE**

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Standard</th>
<th>Title</th>
<th>Reaffirm Date</th>
<th>Amdt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>IS 4770:1991</td>
<td>Rubber Gloves for electrical purposes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2)</td>
<td>IS 5424:1969</td>
<td>Rubber mats for electrical purpose (Superseded by IS 15652:2006)</td>
<td>April 2011</td>
<td>(2)</td>
</tr>
</tbody>
</table>
CHAPTER K

TECHNICAL SPECIFICATION - LIFTS

1. GENERAL

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 moomrock/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 items 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.) microprocessor 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.

2. 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 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.

3. 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.

4. PERMITS, INSPECTION & LICENSE FEE

The contractor shall arrange all necessary local, provincial or national government permit/license and shall make arrangements for inspection and tests required thereby. Expenses to be borne by EPC contractor.

5. 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.

6. 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.

7. 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.

8. 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.

9. **COUNTER BALANCE** :
   
   A suitable guided structural steel frame with appropriate filler weights of cast iron shall be furnished to promote smooth and economic operation.

10. **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.

11. **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.

12. **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.

13. **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.

14. **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.

15. **FOUNDATIONS** :
    
    The machine shall be placed directly above the hoist way upon the machine room slab or as per design.

16. **ROPES** :
    
    The elevator shall be provided with traction steel ropes. Steel wire rope having a tensile strength of not less that 12.5 Ton/cm$^2$ of good flexibility shall be used for lift. The lift rope shall conform to IS: 14665 – (Part-4- Sec-B):2001.

17. **MACHINE** :
    
    The machine shall be gearless type.

18. **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 releases 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.

19. 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 Thermistors embedded in the stator windings for the highest degree of thermal motor protection.

20. 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.

21. 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.

22. DUPLEX COLLECTIVE OPERATION

The operation shall be duplex collective with/without attendant for each elevator and shall consist of the following:

a. 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.

b. 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.

23. Lift Voice Announcement:

The lift shall be provided with floor announcement system with volume control.

24. 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.

25. 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.

26. 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.

27. 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.

28. 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 Braille 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 Braille illuminated push button and a DOWN Braille illuminated 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 until 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.
29. 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 hoistway doors shall be such that the doors shall start opening meant so that by the time the elevator stops completely, the elevator and hoistway 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 hoistway door shall be mechanically connected and shall move simultaneously in opening and closing.

The car and hoistway 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 hoistway 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 hoistway doors shall open automatically as the car is stopping at a landing. The closing of the car and hoistway door must occur before the car can be started. Doors can be stopped and reversed during their closing motion.

30. 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.

31. SAFETY SENSOR:

A safety sensor(one on each door panel) shall extend to the full height of the car door.

32. LANDING ENTRANCE MATERIAL'S:

These shall consist of headers, extruded aluminium sills and strut angles.

33. 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.

34. 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.
35. 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

36. 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 Purpose 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
17. Isometrics screw threads IS-4218
18. Degree for protection provided by enclosure for low voltage switchgear and control gear IS-2147
19. Specification for HRC cartridge fuse links upto 650 volts. IS-2208
20. Code of practice for electrical wiring installation (System voltage not exceeding 650 volts). IS-732
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 & composite unit of air break switches and fuses for voltage not exceeding 1000 volts. IS-4047
24. General requirements for switch gear & controller for voltage not exceeding 1000 volts. IS-4237
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 motor 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 for rotating electrical machinery IS-4691
32. Designation of method of cooling for rotating electrical machines. IS-6362
33. Classification of insulating materials for electrical machinery and apparatus in relation to their thermal stability in service. IS-1271
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 structures against lighting IS-2309
37. Specification for hoist way door locks IS-7754
38. Rules for the design, installation, testing and operation of the lifts, escalator and moving parts. IS-1735
CHAPTER L

TECHNICAL SPECIFICATIONS- HVAC WORKS

1. GENERAL

Scope of work shall include design, engineering, supply, installation, testing & commissioning of HVAC system. All material shall be of conforming to relevant IS specifications wherever exists and subject to approval of Engineer in charge. The HVAC system shall be carried out strictly as per NBC - 2016/ASHRAE/ISHRAE/CPWD/ECBC latest versions.

1.1. 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 GFC drawings as required in advance for approval of Engineer-in-charge.

1.2. GOOD FOR CONSTRUCTION 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 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 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:-

a. General Layout of Plant Room including all details mentioned in clause 1.2
b. Panels and other equipment/accessories location and their dimensions etc.
c. HVAC floor layout including terrace Plan etc.
d. Complete schematic as installed.
e. Route of all cables and pipes run along with detail sizes and mode of installation.

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.

a. Warranty for required equipment installed like Pumps, Panels, Chillers, Cooling Tower, HWG, AHU, FCU etc.
b. As Built Drawings
c. Material Test Certificates
d. Catalogues/Brochures
e. Operation and Maintenance Manuals
f. List of recommended spares and consumables
g. All approvals including technical approvals and sanctions
h. NoC from Fire authority before commencement of execution & after completion of entire work etc.

1.5. 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.

1.6. 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.

1.7. 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

a. 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.

b. The E-I-C may, at his sole discretion, carry out inspection at different stages during manufacturing and final testing after manufacturing.

c. 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

a. 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).

b. The period of training shall be adequate and mutually agreed upon by the Engineer and contractor.

c. The CLIENT/ HITES’s personnel shall also be trained for routine maintenance work and lubrication, overhauling, adjustments, testing, minor repairs and replacement.

d. 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.

a. Any defective material or equipment supplied by the contractor.

b. 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. WATER COOLED CENTRIFUGAL CHILLERS

2.1. GENERAL

Each unit will be completely factory-packaged including evaporator, unit mounted /free standing VFD starter complete with power/ control cabling etc by chiller supplier and condenser, sub-cooler, compressor, motor, lubrication system, view control center and all interconnecting unit piping and wiring. Condenser & evaporator water circuits should be even pass design. The chiller will be painted prior to shipment.

Performance will be certified in accordance with ARI Standard 550/590 and ECBC 2017. Only chillers that are listed in the AHRI/ Eurovent Certification Program for Centrifugal are acceptable.

The initial charge of refrigerant and oil will be supplied, shipped in containers and cylinders for field installation or factory charged in the chiller.

Chiller must unload up to 30% at constant lift conditions without surging and hot gas bypass (i.e. at design chilled out water temperature of 42 Deg. F and design condenser entering water temperature of 88 Deg. F). Computerized sheet mentioning power consumption at part loads at AHRI turndown and constant ECWT of tender conditions must be submitted along with tender for verification from AHRI. Only verified performance sheets will be qualified or approved.

Variable speed must be used.

BMS Compatible & Bacnet/ Modbus output must be provided for integration with 3rd party BMS.

2.2. COMPRESSOR

The compressor will be single / multi-stage centrifugal type in open type / hermetic / semi-hermetic construction. Driven by) electric motors. Compressor shall be designed for 235 psig working pressure and hydrostatically pressure tested at 355 psig for R-134a units or as specified in DBR. The rotor assembly will consist of a heat treated alloy steel drive shaft and impeller shaft with cast aluminum, shrouded impeller. The impeller will be designed for balanced thrust, dynamically balanced and overspeed tested for smooth, vibration-free operation. Insert-type journal and thrust bearings will be fabricated of aluminum alloy, precision bored and axially grooved.

Internal single helical gears with crowned teeth will be designed so that more than one tooth is in contact at all times to provide even load distribution and quiet operation. Each gear will be individually mounted in its own journal and thrust bearings to isolate it from impeller and motor forces. Shaft seal shall be provided in double bellows, double-seal, and cartridge type. Auxiliary forced fed oil reservoir will be built into the the compressor to provide lubrication during coast down in the event of a power failure.

Capacity control will be achieved by use of pre-rotation vanes to provide fully modulating control from maximum to minimum load. The unit will be capable of operating with lower temperature cooling tower water during part-load operation in accordance with ARI Standard 550/590. Pre-rotation vane position will be automatically controlled by an external electric actuator to maintain constant leaving chilled water temperature.
2.3. **LUBRICATION SYSTEM**

Lubrication oil shall be force-fed to all compressor bearings, gears, and rotating surfaces by an external fixed or variable speed oil pump. The oil pump shall vary oil flow to the compressor based on operating and stand-by conditions, ensuring adequate lubrication at all times. The oil pump shall operate prior to start-up, during compressor operation and during coastdown. An emergency lubrication system shall be incorporated in the system to provide lubrication during coast down incase of power failure.

An oil reservoir, separate from the compressor, shall contain the submersible 2 HP or as required oil pump and a suitable capacity oil heater, thermostatically controlled to remove refrigerant from the oil. The oil reservoir shall be designed and stamped in accordance with ASME or GB pressure vessel code. A non-code reservoir is not acceptable.

Oil shall be filtered by an externally mounted 5micron replaceable cartridge oil filter equipped with service valves. Oil cooling shall be done via a refrigerant cooled or water cooled oil cooler, with all piping factory installed (No separate arrangement to be done at site). Oil side of the oil cooler shall be provided with service valves. An automatic oil return system to recover any oil that may have migrated to the evaporator shall be provided. Oil piping shall be completely factory installed and tested.

2.4. **MOTOR DRIVELINE**

The compressor motor shall be an 3 Phase squirrel cage induction type as required, protected against damage by means of built in protection devices. The motor shall be rigidly coupled to the compressor to provide factory alignment of motor and compressor shafts.

2.5. **EVAPORATOR**

Evaporator will be of the shell and tube, flooded type designed for working pressure as per ASME /GB on the refrigerant side and tested against leaks with a pressure of not less than 1.5 times of working pressure. Shell will be fabricated from rolled carbon steel plate with fusion welded seams; have carbon steel tube sheets, drilled and reamed to accommodate the tubes; and intermediate tube supports spaced no more than four feet apart. The refrigerant side will be designed, tested and stamped in accordance with ASME or GB Pressure Vessel Code,. Tubes shall be high-efficiency, internally and externally enhanced type having plain copper lands at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube will be roller expanded into the tube sheets providing a leak-proof seal, and be individually replaceable. Water velocity through the tubes will not exceed 10 fps. The evaporator will have a refrigerant relief device sized to meet the requirements of ASHRAE 15 Safety Code for Mechanical Refrigeration. The chiller shall be insulated with 19 mm thick factory installed elastomeric insulation with vapour barrier. The insulation shall be applied in such a manner that water boxes and covers can be removed without damaging it. Pressure drop on water side shall not exceed, 10m (Ten meters) WC. Water boxes and cover plates will be removable type to permit tube cleaning and replacement. Stub out water connections having flanged connections will be provided. Vent and drain connections with plugs will be provided on each water box.

2.6. **CONDENSER**

Condenser will be of the shell and tube type, designed working pressure as per ASME /GB on the refrigerant side and tested against leaks with a pressure of not less than 1.15 times of working pressure. Shell will be fabricated from rolled carbon steel plate with fusion welded seams; have carbon steel tube sheets, drilled and reamed to accommodate the tubes; and intermediate tube supports spaced no more than four feet apart. The refrigerant side will be designed, tested and stamped in accordance with ASME or GB Pressure Vessel Code,. Tubes shall be high-efficiency, internally and externally enhanced type having plain copper lands at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube will be roller
expanded into the tube sheets providing a leak proof seal, and be individually replaceable. Water velocity through the tubes will not exceed 10 fps.

Pressure drop shall not exceed 10m (Ten metres) water boxes and cover plates will be removable to permit tube cleaning and replacement. Stubout water connections having flanged connections will be provided. Vent and drain connections with plugs will be provided on each water box.

2.7. REFRIGERANT FLOW CONTROL

Refrigerant flow to the evaporator will be controlled by a variable orifice / thermostatic expansion valve for improving unloading capabilities.

COMPRESSOR MOTOR STARTER

The starter will be variable speed drive type and will be factory installed /Free standing type. It will vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. The adaptive capacity control logic shall automatically adjust motor speed and compressor pre-rotation vane position independently for maximum part-load efficiency by analyzing information fed to it by sensors located throughout the chiller. The cooling mechanism shall be either Air Cooled or liquid cooled.

Drive will be utilizing IGBT’s with a power factor of 0.95 or better at full load and speeds.

The variable speed drive will be unit mounted/ free standing type in a IP 54 enclosure with all power and control wiring between the drive and chiller, including power to the chiller oil pump.

The following features will be provided:

- Door interlocked circuit breaker capable of being padlocked.
- Ground fault protection.
- Over voltage and under voltage protection.
- 3-phase sensing motor over current protection.
- Single phase protection.
- Insensitive to phase rotation.
- Over temperature protection.
- Digital readout at the chiller unit control panel of output frequency, output voltage, 3-phase output current, input kilowatts and kilowatt-hours, self-diagnostic service parameters.

KW Meter - The unit’s input power consumption will be measured and displayed digitally via the unit’s control panel.

KWh Meter – The unit’s cumulative input power consumption is measured and displayed digitally via the unit’s control panel.

Ammeter – Simultaneous three-phase true RMS digital readout via the unit control panel. Three current transformers provide isolated sensing. The ammeter accuracy is typically +/- 3% of reading.

Voltmeter – Simultaneous three-phase true RMS digital readout via the unit control panel. The voltmeter accuracy is typically +/- 3% of reading.

Elapsed Time Meter – Digital readout of the unit’s elapsed running time is displayed via the unit control panel.

2.8. GRAPHIC CONTROL CENTER
The chiller shall be controlled by a unit mounted microprocessor based control center. The chiller control panel shall provide control of chiller operation and monitoring of chiller sensors, actuators, relays and switches.

The control panel shall include a color liquid crystal display (LCD) with touch screen control or surrounded by "soft" keys. The screen shall detail all operations and parameters, using a graphical representation of the chiller and its major components. Panel verbiage shall be available in other languages as an option with English always available. Data shall be displayed in either English or Metric units.

The sophisticated program and sensor shall monitor the chiller water temperature to prevent freeze up. When needed hot gas bypass is available as an option. The panel shall display countdown timer messages so the operator knows when functions are starting and stopping. Every programmable point shall have a pop-up screen with the allowable ranges, so that the chiller cannot be programmed to operate outside of its design limits.

The chiller control panel shall also provide:

1. System operating information including:
   a. return and leaving chilled water temperature
   b. return and leaving condenser water temperature
   c. evaporator and condenser saturation temperature
   d. differential oil pressure
   e. percent motor current
   f. evaporator and condenser saturation temperature
   g. compressor discharge temperature
   h. oil reservoir temperature
   i. oil temperature
   j. operating hours
   k. number of compressor starts

2. Digital programming of setpoints through the universal keypad including:
   a. leaving chilled water temperature
   b. percent current limit
   c. pull-down demand limiting
   d. six-week schedule for starting and stopping the chiller, pumps and tower
   e. remote reset temperature range

3. Status messages indicating:
   a. system ready to start
   b. system running
   c. system shutdown
   d. system safety shutdown-manual restart
   e. system cycling shutdown-auto restart
   f. system prelube
   g. start inhibit
4. The text displayed within the system status and system details field shall be displayed as a color coded message to indicate severity.

5. Safety shutdowns enunciated through the display and the status bar, and consist of system status, system details, day, time, cause of shutdown, and type of restart required. Safety shutdowns with a fixed speed drive shall include:
   a. evaporator – low pressure
   b. evaporator – transducer or leaving liquid probe
   c. evaporator – transducer or temperature sensor
   d. condenser – high pressure contacts open
   e. condenser – high pressure
   f. condenser – pressure transducer out of range
   g. auxiliary safety – contacts closed
   h. discharge – high temperature
   i. discharge – low temperature
   j. oil – high temperature
   k. oil – low differential pressure
   l. oil – high differential pressure
   m. oil – sump pressure transducer out of range
   n. oil – differential pressure calibration
   o. oil – variable speed pump – pressure setpoint not achieved
   p. control panel – power failure
   q. motor or starter – current imbalance
   r. thrust bearing – proximity probe clearance
   s. thrust bearing - proximity probe out – of – range
   t. thrust bearing – high oil temperature
   u. thrust bearing – oil temperature sensor
   v. software reboot

5.1 Safety shutdowns with a VSD Shall include:
   a. VSD shutdown – requesting fault data
   b. VSD – stop contacts open
   c. VSD – 110% motor current overload
   d. VSD – high phase A, B, C inverter heatsink temp.
   e. VSD – high converter heatsink temperature

6. Cycling shutdowns enunciated through the display and the status bar, and consists of system status, system details, day, time, cause of shutdown, and type of restart required. Cycling shutdowns with a fixed speed drive shall include:
   a. multiunit cycling – contacts open
   b. system cycling – contacts open
c. oil - low temperature differential

d. oil – low temperature

e. control panel - power failure

f. leaving chilled liquid - low temperature

g. leaving chilled liquid - flow switch open

h. motor controller – contacts open

i. motor controller – loss of current

j. power fault

k. control panel - schedule

l. starter – low supply line voltage

m. starter – low supply line voltage

n. proximity probe – low supply voltage

o. oil - variable speed pump - drive contacts open

6.1 Cycling shutdowns with a VSD shall include all necessary parameters.

7. Security access to prevent unauthorized change of set points, to allow local or remote control of the chiller, and to allow manual operation of the prerotation vanes and oil pump. Access shall be through ID and password recognition, which is defined by three different levels of user competence: view, operator, and service.

8. Trending data with the ability to customize points of once every second to once every hour. The panel shall trend different parameters from a list of over 140, without the need of an external monitoring system.

9. The operating program stored in non-volatile memory (EPROM) to eliminate reprogramming the chiller due to AC power failure or battery discharge. Programmed setpoints shall be retained in lithium battery-backed RTC memory for a minimum of 10 years with power removed from the system.

10. A fused connection through a transformer in the compressor motor starter to provide individual over-current protected power for all controls.

11. A numbered terminal strip for all required field interlock wiring.

12. An RS-232/RS 485 communication port to output all system operating data, shutdown / cycling message, and a record of the last 10 cycling or safety shutdowns to a field-supplied printer. Data logs to a printer at a set programmable interval. This data can be preprogrammed to print for desired time interval.

13. The capability to interface with a building automation system to provide:

   a. remote chiller start and stop

   b. remote leaving chiller liquid temperature adjust

   c. remote current limit setpoint adjust

   d. remote ready to start contacts

   e. safety shutdown contacts

   f. cycling shutdown contacts

   g. run contacts
14 Tests at Factory:

At least one chiller shall be tested on ARI/Eurovent certified test bed at 100%, 75%, 50% and 25% load at AHRI/Eurovent/Design Conditions (to be decided by E-I-C at appropriate stage) to establish IPLV/NPLV at the manufacturer's works and shall be witnessed by client's representatives at factory. Nothing extra shall be paid in this regard.

The scope of work of Contractor shall include suitable capacity of chillers with VFDs as specified in DBR & as per meeting functional requirements complete with R - 134 A refrigerant or as per DBR (ozone friendly, HFC), open / semi hermetic / hermetically sealed single /multiple centrifugal compressors complete with single/twin refrigerant circuit, driven by suitable KW Squirrel Cage induction motor complete with water cooled shell & tube condenser, insulated shell and tube flooded chiller, with S.S braided pipe flexible connector, insulation to be mechanically protected similar to chilled water piping insulation, flanged end for chiller & condenser, electronic auto setting water flow switches at condenser & chiller outlet, factory done refrigerant piping, refrigerant and oil first charged, microprocessor based control panel with non-volatile memory & touch screen display, motor driven by chiller / floor mounted air cooled VSD/VFD with IP 54 (or more) enclosure with active harmonic filters with THDI less than 40% or nearest possible as per OEM & accessories, stainless steel braided pipe flexible connector for chiller and condenser at inlet & outlet, IP 44 enclosure for control and terminal box, factory installed electrical disconnect / isolator switch integrating main fuses etc. all mounted on M.S. frame. Motor shall be suitable for 415 volts ± 10 %, 50Hz ± 5 %, three phase A.C. supply.

It should include flow switch/DP switch at chiller and condenser, vibration isolators, including oil separators, pressure relief devices, filter drier moisture indicators, refrigerant economizer, integral refrigerant piping and wiring, accessories as required and called for, automatic and safety controls mounted in central console panel.

VIII. IEEE519, 1992 recommendations shall be used for the basis of calculation of total active harmonic distortion (THD) at the point of common coupling (PCC) for VFDs.

Suitable PCC/RCC foundation ( PCC foundation in PCC (1:2:4) type B-1 using 20 mm graded stone aggregate 30 cm above floor level including making connection of inlet & outlet with fittings including nut, bolts, packing etc.) with plaster to be provided.

15 CODES & STANDARDS

<table>
<thead>
<tr>
<th>Code/Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASHRAE 15</td>
<td>Safety code for Mechanical refrigeration</td>
</tr>
<tr>
<td>ASHRAE 23</td>
<td>Methods of testing and rating positive displacement refrigerant compressors and condensing units</td>
</tr>
<tr>
<td>ASHRAE 30</td>
<td>Methods of testing liquid chilling packages</td>
</tr>
<tr>
<td>ASME SEC VIII DIV I</td>
<td>Boiler and pressure vessel code</td>
</tr>
<tr>
<td>ANSI B 31.5</td>
<td>Code for refrigeration piping</td>
</tr>
<tr>
<td>AHRI 575</td>
<td>Standard for method of measuring machinery sound within an equipments space</td>
</tr>
<tr>
<td>ISO 1940</td>
<td>Mechanical vibration – Balance quality requirements of rigid rotors</td>
</tr>
<tr>
<td>ISO 10816-1</td>
<td>Mechanical vibration – Evaluation of machine vibration of measurements on non-rotating parts. General guidelines</td>
</tr>
</tbody>
</table>
TEMA: C/R Heat Exchanger with acceptable deviation
ASTM: C591 Specification for Polyurethane/ Poly iso cyanurate Foam.

**TITLE WATER COOLED CHILLER PACKAGE – DATA SHEET A**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Number Required</td>
<td>As per DBR or meeting functional requirement</td>
</tr>
<tr>
<td>2.</td>
<td>Location</td>
<td>As per drawing</td>
</tr>
<tr>
<td>3.</td>
<td>Duty: Continuous</td>
<td>(24 hrs/day) (Approximate)</td>
</tr>
<tr>
<td>4.</td>
<td>Capacity required at specified design conditions per chilling package</td>
<td>As per DBR or meeting functional requirement</td>
</tr>
<tr>
<td>5.</td>
<td>Refrigerant</td>
<td>As per DBR or meeting functional requirement</td>
</tr>
<tr>
<td>6.</td>
<td>Maximum noise level at a distance of 1 meters</td>
<td>85 dBA or as per codal provisions</td>
</tr>
<tr>
<td>7.</td>
<td>Compressor – type</td>
<td>Semi-hermetic/hermetic /Open /centrifugal compressor</td>
</tr>
<tr>
<td>8.</td>
<td>Lubrication</td>
<td>Forced feed with an oil pump / differential pressure</td>
</tr>
<tr>
<td>9.</td>
<td>Capacity control</td>
<td>Automatic</td>
</tr>
</tbody>
</table>

**10. EVAPORATOR**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1</td>
<td>Type</td>
<td>Shell and tube, flooded</td>
</tr>
<tr>
<td>10.2</td>
<td>Liquid to be cooled</td>
<td>Water</td>
</tr>
<tr>
<td>10.3</td>
<td>Chilled water quality</td>
<td>Potable water</td>
</tr>
<tr>
<td>10.4</td>
<td>Chilled water inlet temperature</td>
<td>12.2 Deg C</td>
</tr>
<tr>
<td>10.5</td>
<td>Chilled water outlet temperature</td>
<td>5.5 Deg C</td>
</tr>
<tr>
<td>10.6</td>
<td>Minimum chilled water flow per chilling package</td>
<td>@2 USGPM /TR</td>
</tr>
<tr>
<td>10.7</td>
<td>Fouling factor-water side (FPS unit)</td>
<td>0.0005</td>
</tr>
<tr>
<td>10.8</td>
<td>Chiller and suction line insulation</td>
<td>19mm Closed cell polyvinyl chloride foam or as per Chiller OEM</td>
</tr>
<tr>
<td>10.9</td>
<td>Maximum water side pressure drop</td>
<td>10m of water</td>
</tr>
</tbody>
</table>

**11. CONDENSER**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.1</td>
<td>Type</td>
<td>Water cooled, Shell and tube</td>
</tr>
<tr>
<td>11.2</td>
<td>Liquid to be cooled</td>
<td>Water</td>
</tr>
<tr>
<td>11.3</td>
<td>Condenser water quality</td>
<td>Potable water</td>
</tr>
<tr>
<td>11.4</td>
<td>Condenser water inlet temperature</td>
<td>31 Deg C</td>
</tr>
<tr>
<td>11.5</td>
<td>Condenser water outlet temperature</td>
<td>36.6 Deg C</td>
</tr>
<tr>
<td>S.No</td>
<td>Description</td>
<td>Tenderer To Furnish</td>
</tr>
<tr>
<td>------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>1.0</td>
<td>Water Cooled Chilling Unit</td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>General Data</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Number of chillers</td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>Location</td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>Make and country of origin</td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>Model number and year of introduction model from same factory</td>
<td></td>
</tr>
<tr>
<td>1.6</td>
<td>Detailed list of installations of that model in India from same factory</td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td>Operating Parameters</td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Minimum refrigeration capacity (TR)</td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>Minimum chilled water flow rate (USGPM)</td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>Maximum chiller pressure drop (Feet of water)</td>
<td></td>
</tr>
<tr>
<td>2.4</td>
<td>Entering chilled water temperature (deg F)</td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>Leaving chilled water temperature (deg F)</td>
<td></td>
</tr>
<tr>
<td>2.6</td>
<td>Evaporating temperature (deg F)</td>
<td></td>
</tr>
<tr>
<td>2.7</td>
<td>Fouling factor for chiller</td>
<td></td>
</tr>
<tr>
<td>2.8</td>
<td>KW/TR at full load conditions</td>
<td></td>
</tr>
<tr>
<td>2.9</td>
<td>Entering Condenser water temperature (deg F)</td>
<td></td>
</tr>
<tr>
<td>2.10</td>
<td>Leaving condenser water temperature (deg F)</td>
<td></td>
</tr>
<tr>
<td>2.11</td>
<td>Fouling factor for condenser</td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td>Compressor</td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Manufacturer</td>
<td></td>
</tr>
<tr>
<td>3.2</td>
<td>Model</td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>Type of compressor</td>
<td></td>
</tr>
<tr>
<td>3.4</td>
<td>Speed</td>
<td></td>
</tr>
<tr>
<td>3.5</td>
<td>Speed (maximum)</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>----------------</td>
<td></td>
</tr>
<tr>
<td>3.6</td>
<td>Refrigerant used</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4.0</th>
<th>Evaporator</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Manufacturer</td>
</tr>
<tr>
<td>4.2</td>
<td>Model (No)</td>
</tr>
<tr>
<td>4.3</td>
<td>Shell dia. (mm)</td>
</tr>
<tr>
<td>4.4</td>
<td>Tube length (m)</td>
</tr>
<tr>
<td>4.5</td>
<td>No of tubes (No.)</td>
</tr>
<tr>
<td>4.6</td>
<td>Material of tubes (Name)</td>
</tr>
<tr>
<td>4.7</td>
<td>Dia. of tubes (mm)</td>
</tr>
<tr>
<td>4.8</td>
<td>No of integral fins / cm (No.)</td>
</tr>
<tr>
<td>4.9</td>
<td>No of refrigerant circuits (No.)</td>
</tr>
<tr>
<td>4.10</td>
<td>No of water passes (No.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5.0</th>
<th>Compressor Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>Manufacturer</td>
</tr>
<tr>
<td>5.2</td>
<td>Type</td>
</tr>
<tr>
<td>5.3</td>
<td>Motor Voltage</td>
</tr>
<tr>
<td>5.4</td>
<td>Rated output</td>
</tr>
<tr>
<td>5.5</td>
<td>Power characteristics</td>
</tr>
<tr>
<td>5.6</td>
<td>No of Motors</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6.0</th>
<th>Starter for Compressor Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>Manufacturer</td>
</tr>
<tr>
<td>6.2</td>
<td>Type of starter</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7.0</th>
<th>Miscellaneous Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1</td>
<td>Type of capacity control</td>
</tr>
<tr>
<td>7.2</td>
<td>Noise level of chiller (in dBA) at 1 m distance</td>
</tr>
<tr>
<td>7.3</td>
<td>Equipments size (LXBXH)</td>
</tr>
<tr>
<td>7.4</td>
<td>Equipments operating weight (kg) / pounds</td>
</tr>
<tr>
<td>7.5</td>
<td>Full refrigerant charge quantity</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>8.0</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1</td>
<td>Computerized printout (certified) from chiller manufacturer indicating power consumption in IKW/TR at full load and various part load conditions as per AHRI format</td>
</tr>
<tr>
<td>8.2</td>
<td>Catalogues furnishing detailed technical data for compressor, evaporator, condenser, microprocessor or micro-computer control panel etc.</td>
</tr>
</tbody>
</table>
2.9. **HEAT PUMP**

a) **GENERAL**

Heating Requirement (Actual): As per Requirement  
Hot Water Entering Temperature: 40 Deg. C or as per requirement  
Hot Water Leaving Temperature: 45 Deg. C or as per requirement  
Fouling Factor: 0.0002 MKS or as per requirement  
Air Ambient Temperature: 7 Deg. C or as per requirement  
COP at AHRI Conditions: min. 3.0  
Heating IKW/KW at 100% load at above duty conditions: 0.30  

b) **CHILLED/HOT WATER PRODUCTION**

Chilled and hot water shall be produced by an air-cooled packaged liquid chiller suitable for outside installation. The chiller shall use the ecological refrigerant R410a or other CFC free refrigerant with efficient thermodynamic characteristics, and shall be equipped with scroll compressors. The chiller shall be designed, manufactured and tested in a facility with a quality assurance system certified ISO 9001 and an environment management system certified ISO 14001. All units shall undergo a complete run test in the factory before shipment.

c) **COMPRESSORS**

The compressors shall be quiet hermetic scroll type with low vibration levels, each equipped with a two-pole electric motor cooled by suction gas and protected by internal temperature sensors, an oil charge of synthetic polyolester oil with a level check sight glass, an electronic protection board (Scroll Protection Module) to ensure compressor control, over-temperature protection and high-pressure safety switch control.  
Low noise level and low vibration level shall be guaranteed by:  
- Compressor mountings that are independent from the unit chassis and installed on flexible anti-vibration blocks.  
- Suction and discharge piping support on the compressor discharge side, directly attached to the compressor base to prevent the transmission of vibrations to the unit chassis.

d) **WATER HEAT EXCHANGER**

The unit shall be equipped with a brazed plate type or direct expansion shell and tube type evaporator with two independent refrigerant circuits. The evaporator shall be tested and stamped in accordance with the applicable pressure code. The weld-free copper tubes shall be internally finned and expanded into the tube sheets. The evaporator shall be mounted on support feet with thermal bridge rupture and shall be integrally insulated with 19-mm thick polyurethane foam. The water connections shall be VICTAULIC type connections to ensure quick mechanical disconnection between the unit and the hydronic installation.  
The evaporator shall be equipped with a water drain and a purge plug.

e) **AIR HEAT EXCHANGER**

Fans  
The low-noise direct-drive fans shall be equipped with an impeller with aerodynamic blades and a rotating shroud to ensure optimal leak-tightness between the blades and the fan mouth. The impeller shall be a one-piece type and made of a corrosion-resistant composite material, and
statically and dynamically balanced. The air shall be discharged vertically upwards. The fans shall be protected by polyethylene-coated steel wire grilles. The three-phase electric motors shall have insulation class F, IP 54 protection. They shall have individual overload protection via a disconnect switch.

Condenser

The condenser coils with integrated sub cooling shall be V-shaped with a minimum open angle of 50° to ensure optimum air distribution. The coils shall be equipped with aluminium fins mechanically expanded on to internally finned copper tubes. The condenser coils shall be leak-tested and submitted to a pressure test with dry air.

Power control boxes

The unit shall operate at 400 volts, 3 phases, 50 hertz (400 V ± 10%) without neutral and shall only have one power connection point. The control circuit voltage shall be 24 V maximum, supplied by a factory-installed transformer. The unit shall be equipped with a factory-installed interlockable disconnect/isolating switch.

Unit control

The chiller shall be equipped with microprocessor control, regulating all unit operating and safety parameters in order to optimize energy efficiency and minimize the possibility of the refrigerant circuit shutting down due to a fault. The control system shall ensure the following functions:

Entering and leaving water temperature control by PID loop with equalization of the compressor operating times and number of compressor start-ups

Protection against excessive compressor cycling by auto adaptive control algorithm acting on the leaving water setpoint deadband.

Optimization of the condensing pressure with a floating setpoint based on the outside temperature and the thermal load in order to limit power consumption

Periodic fan start-up when the unit is shut down in order to prolong the operating life of the fans.

Automatic compressor unloading when an abnormally high condensing pressure is detected to prevent the shutdown of the refrigerant circuit due to a high-pressure fault.

f) AUTOMATIC OPERATION

The chiller shall be equipped with a programming timer, permitting:

Unit on/off setting

Changeover to the second setpoint (unoccupied mode)

Demand limitation

The control shall ensure the following operating modes:

On/off mode based on the outside temperature

Setpoint reset based on the outside air temperature or the return water temperature

Master/slave control of two chillers operating in parallel with run time equalization

g) Remote control

The chiller shall include input contacts permitting:

Unit on/off setting

Demand limitation (one stage)

Changeover to the second setpoint (unoccupied mode)
Use of a customer security device

2.10. DX TYPE AIR COOLED PRECISION UNITS

i. GENERAL:-

The room air-conditioning system shall be a floor discharge unit designed specifically for high sensible heat ratio applications such as Server, Computer rooms and UPS room etc.

Each unit shall be capable of providing sensible cooling capacities at rated ambient temperatures with adequate airflow. Each unit shall be capable of providing actual cooling capacity as per requirement.

Inside Conditions: - 22° + 10C and relative humidity is 50 ± 5% RH.

The system shall contain Scroll compressor, Evaporator, Humidifier, Condenser and an Externally Equalized Thermostatic expansion valve (TXV) all of which shall be contained within the cabinet of the unit.

ii. CABINET CONSTRUCTION:-

The frame shall be constructed of Galvanized steel & shall be double skin type. The external panel shall be constructed of 1.2mm zinc coated sheet steel. Front, rear and end panels shall be fitted with 25mm glass fibre insulation, fire rated. The cabinet shall be powder coated and have a textured finish. The hinged front panel shall be removable and include captive ¼ turn fasteners. The cabinet shall be assembled with pop rivets providing ease of disassembly.

iii. FILTRATION:-

The filter chamber shall be an integral part of the system and withdraw able from the front of the unit. Filtration shall be provided by deep V form G4 performance dry disposable media to AS1324.

iv. FANS:-

The fan section shall be designed for an external static pressure of 25 Pa. The fans shall be located downstream of the evaporator coil and be of the forward curved centrifugal type, double width, double inlet and statically and dynamically balanced to G6.3DIN ISO 1940 part I. Each fan shall be separately driven by a high efficiency electric motor with an IP55 enclosure rating. The drive arrangement shall be self-tensioning and provide for belt replacement without the use of tools. The motor base plate shall include locators to ensure optimum axial alignment of the motor.

v. HUMIDIFIER:-

Humidification shall be provided by boiling water in a high temperature polypropylene steam generator. The steam shall be distributed evenly into the bypass airstreams of the environment control system to ensure full integration of the water vapor into the supply air without condensation. The humidifier shall be capable of providing 7.5 kg of steam per hour. The humidifier shall have an efficiency of not less than 1.3 kg/kw and be fitted with an auto flush cycle activated on demand from the microprocessor control system. The humidifier shall be fully serviceable with replacement electrodes. Wastewater shall be flushed from the humidifier by the initiation of the water supply solenoid water valve via a U-pipe overflow system. Drain solenoid valves will not be used.

vi. ELECTRICAL HEATING:-

The electric heating elements shall operate at a heat density level not exceeding 60 kW/ m2. The low watt density elements shall be of finned tubular steel construction finished in high temperature paint.
The heating circuit shall include dual safety protection through loss of air and manual reset high temperature controls.

vii. **COMPRRESSORISED SYSTEMS:-**

   i. **Scroll Compressor:-**

   The compressor shall be of the high efficiency complaint scroll design with an E.E.R. (energy efficiency ratio) of not less than 3.25) at ARI rating conditions. The compressor shall be charged with mineral oil and designed for operation on HCFC R407c or any other CFC free refrigerant. Each compressor shall have internal motor protection and be mounted on vibration isolators.

   ii. **Refrigeration Circuit:-**

   The refrigeration system shall be of the twin circuit direct expansion type and incorporate hermetic scroll compressors, complete with crankcase heaters. Cooling steps shall be a maximum of 50% of total unit cooling capacity for one and two compressor models. The system shall include a manual reset high pressure control; auto reset low temperature switch, externally equalized thermal expansion valve, high sensitivity refrigerant sight glass, large capacity filter drier and charging/access ports in each circuit. Each refrigeration circuit shall include rigidly mounted isolation valves in the discharge and liquid lines to aid servicing and installation (air cooled units only).

viii. **EVAPORATOR COIL:-**

   The evaporator coil shall be A-shape coil (for down flow) incorporating draw-through air design for uniform air distribution. The coil shall be constructed of rifled bore copper tubes and louvered aluminum fins, with the frame and drip tray fabricated from heavy gauge aluminum. All metal parts in contacts with condensate shall be the same material to prevent electrolytic corrosion. The drip trays shall ensure the collection of condensate and be accessible for cleaning.

ix. **DEHUMIDIFICATION:-**

   A specific dehumidification cycle (split-liquid) shall operate by reducing the operating surface temperature in a section of one of the refrigeration coils by means of a solenoid valve in the liquid line. Full airflow of the unit will be maintained at all times to ensure consistent air distribution to the conditioned space.

x. **REMOTE AIR COOLED CONDENSER:-**

   The air cooled condenser shall be the low profile, weatherproof type incorporating high efficiency, direct drive, external rotor motors with axial blade fans. The condenser shall be constructed from heavy-duty aluminum and corrosion resistant components. Heavy duty mounting legs and all assembly hardware shall be included. Condensers shall be suitable for 24-hour operation and be capable of providing vertical or horizontal discharge. The condenser shall be fully factory wired and require a 230-volt 1 phase 50 hz electrical service.

xi. **FAN SPEED CONTROL CONDENSER:-**

   The condenser fans shall be directly driven by 4 pole, 230 volt, 50 hz electric motors with an IP55 enclosure rating and class F insulation. The motor shall be equipped with permanently sealed ball bearing and high temperature grease. The motors shall be speed controlled to ensure stable operating conditions from –50°C to 45 oC ambient by a factory fitted, direct acting pressure actuated fan speed controller. The control system shall be complete with input isolation switch, transducers and pressure switches.

   The high performance heat exchanger shall include mechanically expanded crosshatched copper tubes and louvered aluminum form maximum heat transfer. The coil shall be finished in a high temperature modified epoxy coating to offer increased protection in aggressive environments.
coil shall be have maximum of 3 rows and adequate fins per meter and the face velocity shall not be more than 500 FPM.

xii. UNIT SIZE:-

The maximum footprint area of the unit shall not exceed 1.5 m$^2$. The unit shall require front access (600 mm) only for routine service and installation work.

xiii. UNIT CONTROLLER:-

The unit controller shall be microprocessor based and include a large LCD backlit graphic display for clear visibility of text and graphics. The display and control buttons shall be accessible from the unit front without removing any external panels. The controller shall feature ISP (In-system-Programming) technology to support program upload via a PC.

Control strategies shall be P-I-D with dew point compensation for accurate temperature and humidity control. A selection of return or supply air control shall be provided to suit the application. The controller shall have a user friendly menu driven interface with supporting help screens and shall use multi protocol data communications. Access to the controller settings to prevent against unauthorized access. In normal operating mode screen shall display unit number, temperature and relative humidity set points and actuals, graphs, time, date and operating status. Dynamic icons identify the system operating mode. A 48-hour real time log of temperature and humidity data shall be retained by the control system. All parameters and data shall be protected in memory by an onboard battery. An EIA-232 communications interface shall provide the capability of remote monitoring with the option of EIA-485 interface on 2 or 4 wire connection.

xiv. CONTROL:-

The control system shall allow programming of the following conditions:

- Temperature set point
- Humidity Set point
- High Temperature Alarm
- Low temperature Alarm
- High Humidity Alarm
- Low Humidity Alarm
- The control system shall include the following settable features:
  - Unit identification number.
  - Startup Delay, Cold start Delay and Fan Run on timers
  - Sensor Calibration.
  - Remote shutdown & general Alarm management
  - Compressor Sequencing.
  - Return temperature control.
  - Choice of Modulating output types.

xv. ALARMS:-

The microprocessor shall activate an audible, visual and general alarm in the event of any of the following conditions:

- High Temperature
- Low Temperature
- High Humidity
- Low Humidity
- Loss of Air
- High Pressure
- Low Pressure
- Humidifier Low Water
- Water Under Floor
- Spare Alarm 1 and 2 (Customized text)

The unit shall also incorporate the following protections:

- Single phasing preventors.
- Reverse phasing
- Phase imbalancing
- Phase failure
- Overload tripping (MPCB) of all components

2.11. VARIABLE REFRIGERANT VOLUME/ FLOW SYSTEM

I. 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.

ii. 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.

iii. OUT DOOR UNIT
i. Outdoors units of the VRV/VRF system shall be compact air cooled type, factory assembled, weather proof casing constructed from heavy gauge mild steel panels with powder coated finish.

ii. The outdoor unit should comprise of Inverter controlled Twin Rotary Compressor / Scroll Compressor.

iii. 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.

iv. The ODU must deliver COP of minimum 5.8 at 50 % load.

v. 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.

vi. Allowable level difference between various indoor units connected to one outdoor unit shall be up to 15 m.

vii. 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.

viii. The entire operation of outdoor units shall be through independent remotes of indoor units. No separate Start/ Stop function shall be required.

ix. Complete refrigerant circuit, oil balancing/ equalizing circuit shall be factory assembled & tested.

x. In case of outdoor units with multiple compressors, the operation shall not be disrupted with failure of any compressor.

xi. 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.

IV. 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 sub-cooling 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.

v. 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.

vi. REFRIGERANT CIRCUIT

The Refrigerant Circuit shall include an 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.

vii. 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.

viii. 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 be passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while construction of the joints. Subsequently, it shall be thoroughly blown out using nitrogen.

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.

ix. 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.

3.1. **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.

3.2. **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 46dB(A).

3.3. 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.

3.4. 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).

3.5. 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.

3.6. 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.

3.7. 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

3.8. 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.

3.9. 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.

4. 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.

4.1. 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.

ii. 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.

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, 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 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.

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.

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.

4.2. **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.

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.

ix. **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.

x. **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.

5. **COOLING TOWERS (FRP CONSTRUCTION)**

a) **GENERAL**

The various items of cooling tower shall be complete in all respect and comply with the specification given below, with fan VFDs & should be CTI approved:

b) **DESIGN**

i. **Rating:**

The cooling tower shall be rated for the heat rejection capacity specified.
ii. **Range:**

The Cooling tower shall be designed to cool the requisite quantity of water through 5.5 degree C or as per requirement against the prevailing wet bulb temperature.

iii. **Wet Bulb approach:**

The cooling tower shall be selected for a wet bulb approach of not more than 2.77 degree C.

iv. **Outlet temperature:**

The Cold water temperature from the cooling tower shall match the entering temperature for which the condenser selection is made.

v. **Flow rate:**

The flow rate through the cooling tower shall match the flow rate of the condenser(s) & as specified in DBR.

c) **GENERAL CONSTRUCTION**

Scope of work shall include Supply, Installing, testing and commissioning of FRP Induced draft counter flow COOLING TOWER (with VFD) of suitable capacity as mentioned in DBR or as required for meeting functional requirements for air conditioning system. Each tower shall be complete with FRP water basin, FRP casing, distribution system, PVC filling with integral louvers, drift eliminators, spray nozzles or self rotating sprinklers, statically , dynamically balanced axial flow type fan direct driven or driven through reduction gear box, HDG supporters and GI / Aluminium ladders, make up quick fill arrangement, overflow & drain connections with necessary valves. Electrical isolator at cooling tower shall be provided, duly enclosed in weather proof panel. Motors shall be suitable for 415±10% Volt, 50 Cycles, 3 Phase power supply and high efficiency motor.

Cooling Tower shall be provided with twin cells. VFD designed for HVAC applications for supply air fan with built-in PID controller, control panel (keypad & display) , IP-65 enclosure for use on standard centrifugal fans. The VFDs should not cause any duration of the connected motors and must ensure that class B temperature levels of the connected motors are never exceeded. The display should be in alpha-numeric characters and programming facility should be in user-friendly HVAC terminology. VFD's shall have built in harmonic filters. Each VFD panel to be provided with digital display showing electrical parameters like voltage, current and power consumption.

Each VFD shall be installed in a dedicated external IP-65 enclosure and the inter connecting wires between driver and MCC shall be included. Operation of VFD system shall be based approach of cooling tower & fan should be working in a modulating way & it should be complete with necessary sensors& controllers. It should be complete with cement concrete foundation, steel/masonry supporting structure, anti vibration mountings etc. Electrical Isolator for each cooling tower shall be provided at terrace.

The cooling towers shall be of FRP, vertical induced draft, cross /counter flow type complete with FRP basins, FRP body, fan and motor assembly, VFD, fill media, distribution pipes, concrete-steel foundations etc. Drive Motor : The fan motor shall be premium efficiency IE3 class as per IS 12615.

All steel components including assembly hardware shall be hot dip galvanized (G-235 Grade).

The body shall be made of FRP (fibre glass reinforced plastic) sections of equal segments, all bolted together. The surface on both inside and outside shall be smooth, for minimum air resistance. The fan deck shall form an integral part of the body. The structural strength of the body shall be sufficient to withstand wind velocities upto 160 KM/HR., vibration and
earthquakes. The structural framework of the cooling tower including all members shall be designed for the load encountered during the normal operation of the cooling tower and its maintenance. The structure shall be rugged and rigid to prevent distortion and shall include tie arrangements as may be necessary. The supporting framework for the tower casing and the water basin shall be made of hot dip galvanized steel and it shall be further protected with epoxy painting.

The filling shall be of PVC. Thickness of PVC fills shall not be less than 0.2 mm. These shall be of such construction as to provide low air resistance, large wetted surface for a high heat transfer efficiency, and easy replaceability.

The water distribution shall be either through fixed type sprinklers or through balancing, sub balancing and spreader troughs (un pressurized system) “open gravity type with polypropylene nozzle”, ensuring uniform water loading and distribution of water over the fill. All pipes and fittings shall be of PVC. The sprinklers shall operate from the residual velocity head at the headers. Due care shall be taken with regard to corrosive effects and maintainability in the design of the water distribution system.

Drift eliminators of PVC shall be provided for maximum removal of entrained water droplets. The spacers and tie rods used shall be of plastic material. Drift losses for the cooling tower should not be more than 0.00091%/0.02% of the circulated water.

The water basin shall also be of FRP having an auxiliary suction tank, at the bottom. The basin shall be complete with connections for drain, overflow, make up water, quick fill float valve, drain valve & a hot water bleeds connection.

A thermostat shall be provided in the sump of the Cooling Tower, to sense the water temperature and to switch off the Fan motor during night times and other favorable weather conditions.

d) INSTALLATION

The cooling towers will be located at a well-ventilated place on the terrace of the plant room building. The structural loading of the terrace shall be considered. Cooling towers shall be installed in such a way that their load is transferred directly to the columns for which necessary Mild steel-I sections shall be provided by the air conditioning contractor. The cooling towers shall be rested on Mild steel-I sections and not on terrace slab. Sufficient free space shall be left all around for efficient operation of the cooling tower.

The support structures for the tower shall be of mild steel duly hot dipped galvanised.

e) WATER DISTRIBUTION SYSTEM

The hot water shall be distributed through a gravity system having a uniform slash through removable nozzles placed at the floor of basin. It should provide full coverage of fill hot water basin suitably covered with GRP sheet to eliminate algae formation.

f) FAN ASSEMBLY

The fan shall be of axial flow type with cast aluminium multiple blades of aerofoil design and adjustable pitch. The fan assembly shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 10 M/S and the tip speed shall be below 4500 m/min.

The fan guard shall be hot dipped galvanized with wire mesh screen to prevent bird nesting during idling period.

The fan shall be directly mounted on the motor or through speed reduction gears. In the latter case, the housing shall be of heavy cast iron, construction with large oil reservoir.
The fan motor shall be totally enclosed fan cooled squirrel cage type conforming to I.P.55 for outdoor operation. The fan guard shall be hot dipped galvanized.

The total sound intensity with all fans in operation shall not exceed 80 DB(A) at a distance of 3 meters from the nearest face of tower. It should also be in compliance with CPWD norms or any other relevant codes.

g) LADDER

All towers, whose height exceeds 2.5m, shall be provided with a ladder, made out of Stainless Steel and with a safety cage and hand railing.

h) ACCESSORIES

Each cooling tower to include:

i) Valve at make up, quick fill, make up float valve and drain valve.

ii) A hot water bleeds connection to the drain line through a stop valve.

i) TESTING

Tower performance curves shall be furnished. Acceptance test to demonstrate the performance of the installed cooling tower shall be conducted in accordance with the current ASME power test code for the atmospheric water cooling equipment and test result shall show tower capacity (computed from the performance curves) within +5% of the specified capacity at the designed W.B.

---

**TITLE COOLING TOWER – DATA SHEET A**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Number Required</td>
<td>As per DBR &amp; meeting functional requirement</td>
</tr>
<tr>
<td>2.</td>
<td>Location</td>
<td>As per drawing</td>
</tr>
<tr>
<td>3.</td>
<td>Duty: Continuous</td>
<td>(24 hrs/day) (Approximate)</td>
</tr>
<tr>
<td>4.</td>
<td>Wet bulb approach</td>
<td>less than 2.77°C</td>
</tr>
<tr>
<td>5.</td>
<td>Capacity at</td>
<td>2085870 K.CAL/Hr or as per requirement</td>
</tr>
<tr>
<td></td>
<td>Flow Rate: 6530 LPM or as per requirement</td>
<td>Water Temp. IN: 36.6°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water Temp. OUT:31.1°C</td>
</tr>
<tr>
<td>6.</td>
<td>Maximum noise level at a distance of 3 meters</td>
<td>Less than 80 dBA</td>
</tr>
<tr>
<td>7.</td>
<td>Motor efficiency</td>
<td>(IE-3) VFD Controlled</td>
</tr>
<tr>
<td>8.</td>
<td>Ladder material</td>
<td>SS ladder</td>
</tr>
</tbody>
</table>

---

**TITLE COOLING TOWER – DATA SHEET B- DETAILS TO BE FURNISHED BY TENDERER**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Manufacturer</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Model</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Wet bulb approach</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>No. of Fans / HP</td>
<td></td>
</tr>
</tbody>
</table>
6. Overall dimensions (mm)

7. Weight with water (kg.)

8. Outlet velocity (mts. Per min)

9. Tip speed (Mts per min)

10. Drift loss (LPH)

11. Total water loss (LPH)

12. Noise level at a distance of 3 meters

13. Capacity at Flow Rate:
   Water Temp. IN:
   Water Temp. OUT:

14. Motor efficiency

6. PUMPS – SPECIFICATIONS (MOTORS EFFICIENCY IE-3 RATED WITH VFD'S)

   a) SCOPE

      This section of specification covers the supply, installation, testing, commissioning of water pumps along with accessories conforming to these specifications and in accordance with DBR & Functional requirements.

   b) CODES AND STANDARDS

      The design, materials of construction, manufacture, inspection, performance and testing of End Suction / Vertical Inline Long Coupled Centrifugal Pumps with unit mounted VFDs shall comply with all currently applicable statutory regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall be construed to relieve the Contractor of this responsibility. The equipment supplied shall comply with the latest applicable Indian, American, British or equivalent standards.

   c) TYPE

      All chilled (primary/secondary), condensing water pumps, hot water pumps shall be of capacity and size in accordance with the requirements indicated in the drawings or DBR and as per requirements. Pumps shall conform to relevant IS standards/codes.

   d) MATERIAL OF CONSTRUCTION

      Centrifugal inline long coupled type with the following material of construction.

      Vertical Inline Centrifugal Pump shall be selected for chilled / hot / condenser water recirculation duty. The pump casing shall have heavily ribbed construction, suction and discharge connection shall be flanged of the same size and shall be drilled and tapped for seal flush and gauge. The impeller made of bronze shall be double shrouded, single entry, radial flow type. It shall be hydraulically balanced to minimize axial thrust. The stuffing box shall be factory fitted with mechanical seal.

      The pump is to be fitted with a factory installed flush line. Supply in the flush line to the mechanical seal, a 50 micron cartridge filter (alternatively, a cyclone separator when pump differential pressure exceeds 30 PSIG) and floating ball type sight flow indicator suitable for the working pressure encountered. The mechanical contractor shall change the filters after the system has been flushed and on a regular basis until the pumps are turned over to the owner.
The axially split, spacer type rigid coupling shall be used to allow seal maintenance without disturbing the pump or motor connections. The mechanical seal shall be accessible and easily replaced.

On the discharge side of each pump factory supplied combination Valve shall be provided to incorporate the following three functions in one body:

- Tight shut-off,
- spring-closure type silent non-slam check and
- effective throttling.

The body shall have (2) 1/4" NPT connections on each side of the valve seat. Two connections to have brass pressure and temperature metering ports, with EPDM check valves and gasketed caps. Two other connections to be supplied with drain plugs. Metering ports are to be interchangeable with drain ports to allow for measurement flexibility when installed in tight locations. The valve disc shall be bronze plug & disc type with EPDM seat to ensure tight shut-off and silent check operation. The valve stem shall be stainless steel with flat surfaces provided for adjustment with open-end wrench.

For Grooved Piping: Valve body shall be ductile iron with grooved ends and anti-rotation lugs on the inlet and outlet of the body.

Flange adapters, where necessary are to be ductile iron flanges with anti-rotation lugs and EPT gaskets. Valve body shall be Cast Iron with PN16 flanged ports.

The valve shall be selected and installed in accordance with the manufacturer’s instructions and be suitable for the pressure and temperature specified.

On the suction of each pump factory supplied suction guide, with Outlet Flow Stabilizing Guide Vanes, removable Stainless Steel Strainer and Fine Mesh Start-up Strainer shall be provided.

Supply suction guide with carbon steel body, carbon steel guide vanes and PN16 flanged ports.

Strainer element shall be stainless steel construction with 0.125" (3 mm) perforations. Fine mesh start-up strainer shall be 20 mesh galvanized steel. The mechanical contractor shall inspect the strainer prior to activating the pump and, further, shall remove the Fine Mesh Start-up Strainer after a short running period. (24 hours maximum). Space shall be provided for removal of the strainer and connection of a Blow-down Valve.

The construction of Vertical Inline Pumps shall be as follows and as per IS 1520

<table>
<thead>
<tr>
<th>Duty</th>
<th>Chilled / Hot / Condenser Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casing</td>
<td>Cast Iron</td>
</tr>
<tr>
<td>Impeller</td>
<td>Bronze</td>
</tr>
<tr>
<td>Pump Shaft</td>
<td>Stainless Steel Grade 416</td>
</tr>
<tr>
<td>Bearings</td>
<td>Ball / Journal Bearing</td>
</tr>
<tr>
<td>Speed (Synchronous)</td>
<td>1500 RPM</td>
</tr>
<tr>
<td>Motor</td>
<td>TEFC</td>
</tr>
<tr>
<td>Mechanical seal</td>
<td>Factory fitted</td>
</tr>
</tbody>
</table>

The impellers of pumps shall be statically and dynamically balanced.
The end suction split casing pumps shall conform to ISI 1520 and the construction of the pumps shall be as follows.

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>DESCRIPTION OF COMPONENT</th>
<th>MATERIAL / TYPE OF CONSTRUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Pump Casing</td>
<td>Close grained cast iron of heavy section, end suction back pull out type and machined to close tolerance.</td>
</tr>
<tr>
<td>2.</td>
<td>Impeller</td>
<td>Bronze/Gunmetal machined to close tolerance.</td>
</tr>
<tr>
<td>3.</td>
<td>Pump Shaft</td>
<td>High quality alloy steel EN8 grade.</td>
</tr>
<tr>
<td>5.</td>
<td>Shaft sleeves</td>
<td>Gun metal.</td>
</tr>
<tr>
<td>6.</td>
<td>Base frame</td>
<td>Cast-iron/fabricated out of MS channel in all welded Construction.</td>
</tr>
<tr>
<td>7.</td>
<td>Flanges</td>
<td>As per ISI standards.</td>
</tr>
<tr>
<td>8.</td>
<td>Stuffing box</td>
<td>Mechanical seal.</td>
</tr>
<tr>
<td>9.</td>
<td>Pump coupling</td>
<td>Flexible steel pin and rubber bushing type protected by guard.</td>
</tr>
</tbody>
</table>

e) **CONSTRUCTION DETAILS.**

i. **End suction vertical back pull out**

The pump casing shall be end suction vertical back pull out type and the pump shall be installed such that the internal parts of the pump like impeller, mechanical seal and bearing etc can be serviced without disconnecting the pipes or disturbing the motor and pump alignment. The joining faces of the pump casing shall be machined and ground to smooth finish and sealed with leak proof gasket. The suction passages of the pump shall be volute in form thereby allowing smooth entry of water to the impeller. The impeller shall be double suction, enclosed type, statically and dynamically balanced. The impeller water passages shall be smoothly finished to ensure minimum friction loss and maximum efficiency. The pump shall be supported by two precision bearings grease or oil lubricated. The pump casing and the internal components shall be designed to withstand the discharge pressure plus the static water head + additional 50% of the total pressure.

ii. **Split casing type**

The pumps shall be radially split, single stage centrifugal type with CI/GM casing with equal size suction and discharge flanges and having separate tapped flush line and pressure gauge connections, Gunmetal Bronze (BS1400 LG2C) dynamically balanced impeller, stainless steel shaft, lower carbon throttle bushing, Outside Balanced type mechanical seal with Resin Bonded Carbon rotating face, Sintered Silicon Carbide stationary seat and Viton secondary seal.

The pump is to be fitted with a factory installed flush line. Supply in the flush line to the mechanical seal, a 50 micron cartridge filter (alternatively, a cyclone separator when pump differential pressure exceeds 30 PSIG) and floating ball type sight flow indicator suitable for the working pressure encountered. The mechanical contractor shall change the filters after the system has been flushed and on a regular basis until the pumps are turned over to the owner. The squirrel cage induction type motor, with TEFC enclosure and shall be connected to the pump through a high tensile aluminum, split type spacer coupling to permit
Servicing of the mechanical seal without disturbing pump, motor or electrical wiring. Coupling shall be protected by a guard.

f) **PUMP ACCESSORIES.**

The following accessories and fixture will be provided with each pump along with other standard accessories.

a. Air vent valves.

b. Drain Plug.

c. Seal Connections.

d. Lubrication fixture (Lubrication fittings) & mechanical seal.

e. Suction & delivery shut off valves.

f. Non return valve.

g. Water pressure gauges on inlet and outlet pipes. (Included in pumps)

h. Y-type strainer on suction pipe.

g) **MOTOR CAPACITY**

The capacity of motor shall be 10% in excess of BHP requirement of pump & shall be as per Standard Specifications. The tenderer shall provide detailed calculation for selection of pumps.

h) **ACCESSORIES AND FITTINGS**

Pump shall be complete with

i. Lubrication fittings

ii. Gland drains (25mm min) piping upto nearest floor drain point.

iii. Test and air vent cocks.

iv. Water seal piping connections

v. Suction, discharge pressure gauge (not less than 150 mm diameter) of appropriate range, with globe valves.

vi. Suction and discharge shut off valves.

vii. Discharge check valve

viii. Y type strainer at suction of each pump

ix. Flexible couplings (at section & discharge) with control rods.

x. However quantities of item (e) to (i) are separately quantified in ‘DBR’ and as such, cost of these valves should not be included in the cost of pump.

Also Gi gland drain piping (Item b) upto nearest drain point will be paid under piping item; as such cost of same should not be included in the cost of pump.

i) **DESIGN REQUIREMENTS**

i. The pump shall be capable of developing the required total head at rated capacity for continuous operation.
ii. Pumps shall run smooth without undue noise and vibration. The noise level shall be limited to 85 db A at a distance of one meter.

iii. The guaranteed output of the pump shall be at that frequency of electric supply, which is normally available at site, instead of rated frequency of 50 Hz, if, specified in Data Sheet ‘A’.

iv. Pump motor shall be suitable for 415 +/- 5% V, 3-phase 50 CPS AC power supply.

j) FEATURES OF CONSTRUCTION

i. Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. Components of identical pumps shall be interchangeable.

ii. Mechanical seals shall be provided.

k) INSTALLATION & TESTS

The pump sets shall be mounted on cement concrete foundation, which shall be provided by other agencies. However, grouting nuts, bolts, channels, shims etc shall be provided by the HVAC contractor.

Pumps shall be installed as per manufacturer's recommendations. Pump set shall be mounted on concrete block which in turn is mounted on machinery isolation cork or any other equivalent vibration isolation fitting.

Concrete foundation will be made by the Contractor as per approved drawings and specifications and the isolation pad foundation bolts, etc., shall also be supplied by the Contractor. Contractor shall ensure that the foundation bolts are correctly embedded.

Pump sets shall preferably be factory aligned whenever necessary; site alignment shall be done by competent persons. Before the foundation bolts are grouted and the coupling bolted, the bed plate levels and alignment results shall be submitted to the Engineer.

l) MECHANICAL BALANCING

The impeller shall be statically and dynamically balanced.

m) VISUAL INSPECTION

Pumps shall be offered for Visual inspection (if specifically asked for) before dispatch. The components of the pumps shall not be painted before inspection.

n) MATERIAL TEST CERTIFICATE

Materials of the various pump components shall be tested in accordance with the relevant standard and Test Certificates shall be furnished along with the Pumps.

o) FIELD TESTING

After installation, the pumps shall be subjected to testing at site also. If the performance does not meet the requirements regarding capacity, power consumption, vibration and noise etc. as specified, then the equipment shall be rectified or replaced by the Contractor, at no extra cost to the HITES.

p) SHOP/G.A DRAWINGS

The following drawings shall be submitted for shop drawing approval:

i. Preliminary outlines dimensional drawing of pump. (Suction and discharge connections and foundation details shall also be indicated).
ii. Performance curves (capacity vs. total head, efficiency, NPSH and KW requirement) ranging from zero to maximum capacity.

iii. Pump Catalogues.

q) **NAME PLATE**

Each pump shall be provided with a name plate indicating the following details:-

a) Design capacity
b) Total head
c) Speed
d) Motor rating
e) Model number
f) Manufacturer’s serial number
g) Weight of equipment
h) Tag number

r) **PAINTING**

All ferrous surfaces shall be painted with one coat of red oxide primer paint followed by two coats of synthetic enamel paint (approved shade).

s) **INSULATION**

i. The Pump casings for chilled water along with its accessories and fittings shall be insulated as specified in section on insulation. The cost of this insulation should be included in the cost of the pump.

ii. Pumps shall be insulated only after they have been tested and test results have been approved by the engineer.

Note: - All the hardware required for the installation and equipments required for testing & commissioning shall be supplied by the Contractor.

7. **VARIABLE SPEED PUMPING SYSTEM**

i. **SCOPE**

The scope of this section comprises the supply, erection, testing and commissioning of variable speed pumping package consisting of following:

a. Individual Components
b. Pump Control Panel
c. Adjustable Frequency Drive
d. Different pressure transmitted
e. Logic Programming for sequence of Operation
f. Power wiring and control wiring shall be carried out by installation contractor as shown on the field connection drawings and wiring diagrams supplied with the pumping package.

ii. **REFERENCES**

a. ANSI - American National Standards Institute
b. NEMA - National Electrical Manufacturers Association  
c. UL - Underwriters Laboratories Inc.  
d. ETL - Electrical Testing Laboratories  
e. CSA - Canadian Standards Association  
f. NEC - National Electrical Code  
g. ISO - International Standards Organization  
h. IEC - International Electrochemical Commission  

iii. SUBMITTALS  
Submittals shall include the following and shall be specific to this project. General Submittals shall not be accepted.  
b. Sequence of operation  
c. Shop drawing indicating dimensions, required clearances and location and size of each field connection.  
d. Power and control wiring diagrams.  
e. System profile analysis including variable speed pump curves and system curve. The analysis shall also include pump, motor and Adjustable Frequency Drive (AFD) efficiencies, job specific load profile, staging points, horse power and kilowatt/hour consumption.  
f. Pump data sheets.  

iv. QUALITY ASSURANCE  
a. The pumping package shall be assembled by the pump manufacturer. An assembler of pumping systems not actively engaged in the design and construction of centrifugal pumps shall not be considered a pump manufacturer. The manufacturer shall assume “Unit Responsibility” for the complete pumping package. Unit responsibility shall be defined as responsibility for interface and successful operation of all system components supplied by the pumping system manufacturer.  
b. The manufacturer shall have a minimum of 20 years experience in the design and construction of variable speed pumping systems.  
c. The local supplier of Chilled Water Variable Speed Pumping System (VSPS) shall have relevant expertise in all aspects of design, application engineering, installation, programming, interfacing, commissioning and after sales service. Supplier must have commissioned minimum 25 sets of chilled water VSPS in India.  
d. All functions of the variable speed pump control system shall be tested at the factory prior to shipment. This test shall be conducted with motors connected to AFD output and it shall test all inputs, outputs and program execution specific to this application.  
e. The manufacturer shall be fully certified by the International Standards Organization per ISO 9001. Proof of this certification shall be furnished at time of submittal.  
f. Manufacturer shall be listed by Underwrite’s Laboratories as manufacturer of packaged pumping systems.
g. Tenderer shall comply with all sections of this specification relating to packaged pumping systems.

v. MANUFACTURED UNITS

a. Furnish and install as shown on the plans a Variable Speed Pumping System as per approved manufacturers.

b. The control system shall include as, a minimum, the programmable logic pump controller, adjustable frequency drive(s) and remote sensor / transmitters as per requirements. Additional items shall be included as specified or as required to properly execute the sequence of operation.

c. The variable speed pump logic controller, adjustable frequency drives, AFD bypass as per requirement, and remote sensor / transmitters shall be shipped as individual components to the job site.

d. Pump logic controller, adjustable frequency drives, sensor / transmitters and related equipment shall be installed by the mechanical contractor as shown on the plans.

e. Power wiring shall be installed by the mechanical contractor as shown on the field connection drawings and wiring diagrams supplied with the pumping package.

f. Low voltage wiring shall be installed by the mechanical controls contractor as shown on the field connection drawings and wiring diagrams supplied with the pumping package.

vi. PUMP LOGIC CONTROLLER

a. The pump logic controller assembly shall be listed by and bear the label of Underwriter's Laboratory INC. (UL). The controller shall meet Part 15 of FCC regulations pertaining to class A computing devices. The controller shall specifically designed for variable speed pumping applications.

b. The controller shall function to a proven program that safeguards against hydraulic conditions including:

i. Pump flow surges

ii. Hunting

iii. End of curve

iv. System over pressure.

v. NPSHR above NPSHA

vi. Motor overload

c. The pump logic controller shall be capable of receiving up to two discrete analog inputs from zone sensor / transmitter as indicated on the plans. It will then select the analogue signal that has deviated the greatest amount from its setpoint. This selected signal shall be used as the command feedback input for a hydraulic stabilization function to minimize hunting. Each input signal shall be capable of maintaining a different set point value. Controller shall be capable of controlling upto five pumps in parallel.

d. The pump logic controller shall have an additional analog input for a flow sensor. This input shall serve as the criteria for the end of curve protection algorithm.
e. The hydraulic stabilization program shall utilize a proportional-integral-derivative control function. The proportional, integral and derivative values shall be user adjustable over an infinite range.

f. The pump logic controller shall be self-prompting. All messages shall be displayed in plain English. The operator interface shall have the following features:

i. Multi-fault memory and recall last 10 faults and related operational data

ii. Red fault light, Yellow warning light and Green power on light.

iii. Soft-touch membrane keypad switches.

g. The display shall have four lines, with 20 characters on three lines and eight large characters on one line. Actual pump information shall be displayed indicating pump status.

h. Controller shall be capable performing the following pressure booster function

i. Low suction pressure cut-out to protect the pumps against operating with insufficient suction pressure.

ii. High system pressure cut-out to protect the piping system against high pressure conditions.

iii. No flow shut down to turn the pumps off automatically when system demand is low enough to be supplied by hydropneumatic tank. No flow shutdown shall require any external flow meters, flow switches, nor pressure switches to determine when a No Flow condition exists.

i. The following communication features shall be provided to BAS:

i. Remote system start / stop non-powered digital input.

ii. Failure of any system component. Output closes to indicate alarm condition.

iii. One 4-20 mA output with selectable output of:

• Frequency
• Process Variable
• Output Current
• Output power.

j. The following communication features shall be provided to the building automation system via an RS-485 port utilizing Johnson Controls Metasys N2 protocol or equivalent protocol.

i. Individual Analog Input

ii. Individual Zone Set Points.

iii. Individual Pump / AFD on/off status.

iv. System percent speed.

v. System Start / Stop command

vi. System operation mode.

vii. Individual KW signals.

viii. System flow, when optional flow sensor is provided.
k. The pump logic controller shall be as per requirements & housed in a NEMA 3S / IP 54 Enclosure.

vii. ADJUSTABLE FREQUENCY DRIVE

a. The adjustable frequency drives shall be Pulse Width Modulation (PWM) type, microprocessor controlled design.

b. The Adjustable Frequency Drive (AFD), including all factory installed option, be tested to UL standard 508. The AFD shall also meet C-UL and be CE marked and built to ISO 9001 standards.

c. The AFD shall be housed in a IP 55 or nearest as per OEM standards enclosure. AFD with plastic enclosure shall not be acceptable.

d. The AFD shall employ and advanced sine wave approximation and voltage vector control to allow operation at rated motor shaft output speed with no derating. This voltage vector control shall minimize harmonics to the motor to increase motor efficiency and lift. Power factor shall be near unity regardless of speed or load.

e. The AFD shall have balanced DC link reactors to minimize power line harmonics AFDs without a DC link reactor shall provide a 3% impedance line reactor.

f. Input and output power circuit switching can be done without interlocks or damage to the AFD.

g. The following customer modifiable adjustments shall be provided:
   i. Accel time.
   ii. Decel time.
   iii. Minimum Frequency.
   iv. Maximum Frequency.

h. RS-485 communication for Johnson Controls N2 shall be available and provided as an option.

i. An automatic energy optimization selection feature shall be provided. This feature shall reduce voltage when lightly loaded and provide a 3% to 10% additional energy savings.

j. The AFD shall be suitable for upto 3300 feet elevation above sea level without derating. Maximum operating ambient temperature shall not less than 104 degrees F. AFD shall be suitable for operation in environments upto to 95% non-condensing humidity.

k. The AFD shall be capable of displaying the following information in plain English via an alphanumeric display:
   i. Frequency.
   ii. Voltage
   iii. Current
   iv. Kilowatts per hour
   v. Fault Identification.
   vi. Percent Torque.
   vii. Percent Power
viii. RPM

viii. AUTOMATIC AFD BYPASS

a. Variable speed pumping system shall be equipped with an automatic bypass in accordance with requirement.

b. Bypass shall consist of a main power disconnect with ground fault protection, a pair of interlocked contractors and a motor overload relay. All are to be mounted in a NEMA 3S / IP 54 enclosure.

c. Automatic bypass shall operate as shown in schematic drawings described in the sequence of operation.

ix. SENSOR / TRANSMITTERS

Provide field mounted differential pressure sensor transmitters as indicated in required. Unit shall transmit an isolated 4-20mA dc signal indicative of process variable to the pump logic controller via standard two wire 24 DC system. Unit shall have a corrosion resistant steel body with 1/8" NPT process connection.

It shall have a NEMA 4 electrical enclosure capable of withstanding requisite static pressure. Accuracy shall be within 0.5% of full span. The installation contractor shall ensure that these differential pressure sensor are enclosed within pilfer proof housing such MS plate housing with lockable access panel.

x. SEQUENCE OF OPERATION

a. The system shall consist of a pump logic controller, multiple pump / AFD sets, with manual and automatic alternation and pump staging.

b. The pumping system shall start upon the closure of contact when the pump logic controller Mode of Operation selector switch is in the REMOTE position.

c. When the pump logic controller selector switch is in the LOCAL position, and start command on Tech 500 is given via operator interface, the pumping system shall operate automatically.

d. Sensor / transmitters shall be provided as indicated on the plans.

e. Each sensor / transmitter shall send a 4-20 mA signal to the pump logic controller, indicative of process variable condition.

f. The pump logic controller shall compare each signal to the independent, engineer / user determined set points.

g. When all set points are satisfied by the process variable, the pump speed shall remain Constant at the optimum energy consumption level.

h. The pump logic controller shall continuously scan and compare each process variable to its individual set point and control to the least satisfied zone.

i. If the set point cannot be satisfied by the designated lead pump, the pump logic controller shall initiate a timed sequence of operation to stage a lag pump.

j. The lag pump shall accelerate resulting in the lead pump(s) decelerating until they equalize in speed.

k. Further change in process variable shall cause the pumps to change speed together.

l. When the set point criteria can be safely satisfied with fewer pumps, the Technologic pump logic controller shall initiate a timed destage sequence and continue variable speed operation.
m. As the worst case zone deviates from set point, the pump logic controller shall send the appropriate analog signal to the AFD to speed up or slow down the pump / motor.

n. In the event of a AFD fault, the pump logic controller automatically initiates a times sequence of events to start the redundant pump / AFD set in the variable speed mode. The redundant variable speed system shall be started through the pump logic controller.

o. Upon AFD fault(s), the pump controller shall display an alarm condition through a plain English message.

p. AFD fault indication shall be continuously displayed on the operator interface of the pump until the fault has been corrected and the controller has been manually reset.

q. In the event of the failure of a zone sensor / transmitter, its process variable signal shall be removed from the scan / compare program. Alternative zone sensor / transmitters, if available, shall remain in the scan / compare program for control.

r. Upon sensor failure, a plain English warning message shall be displayed on the operator interface of the pump logic controller.

s. In the event of failure to receive all zone process variable signals, a user selectable number of AFDs shall maintain a user adjustable speed; reset shall be automatic upon correction of the zone failure.

**CENTRIFUGAL PUMPS-DATA SHEET A**

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Pump Designation</th>
<th>Primary / Secondary Chilled Water Pumps / Condenser Water Pumps / Hot Water Pumps/ reheat pumps</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No. of Pumps</td>
<td>As mentioned in DBR</td>
</tr>
<tr>
<td>2</td>
<td>Design Capacity</td>
<td>As mentioned in DBR</td>
</tr>
<tr>
<td>3</td>
<td>Total Head</td>
<td>As mentioned in DBR</td>
</tr>
<tr>
<td>4</td>
<td>Location</td>
<td>AC plant room &amp; reheat pumps on terrace of hospital.</td>
</tr>
<tr>
<td>5</td>
<td>Max. Rated Sped (at 50 Hz)</td>
<td>1450 RPM</td>
</tr>
<tr>
<td>6</td>
<td>Liquid Handled</td>
<td>Water</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Features of Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>9</td>
</tr>
<tr>
<td>10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Materials of Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
</tr>
<tr>
<td>11.1</td>
</tr>
<tr>
<td>11.2</td>
</tr>
<tr>
<td>11.3</td>
</tr>
</tbody>
</table>

**CENTRIFUGAL PUMPS- DETAILS TO BE FURNISHED BY TENDERER—**
### DATA SHEET B

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>ITEM DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Make</td>
</tr>
<tr>
<td>2.</td>
<td>Model</td>
</tr>
<tr>
<td>3.</td>
<td>Design Capacity</td>
</tr>
<tr>
<td>4.</td>
<td>Total Head</td>
</tr>
<tr>
<td>5.</td>
<td>Shut off head</td>
</tr>
<tr>
<td>6.</td>
<td>Hydrostatic test pressure</td>
</tr>
<tr>
<td>7.</td>
<td>Pump efficiency at duty point</td>
</tr>
<tr>
<td>8.</td>
<td>Power input to pump at duty point</td>
</tr>
<tr>
<td>9.</td>
<td>Motor efficiency at duty point</td>
</tr>
<tr>
<td>10.</td>
<td>Power input to motor at duty point</td>
</tr>
<tr>
<td>11.</td>
<td>Rated speed</td>
</tr>
<tr>
<td>12.</td>
<td>NPSH required</td>
</tr>
<tr>
<td>13.</td>
<td>Material of construction as per specification, If no, indicate deviations</td>
</tr>
<tr>
<td>14.</td>
<td>Suction size</td>
</tr>
<tr>
<td>15.</td>
<td>Discharge size</td>
</tr>
<tr>
<td>16.</td>
<td>Impeller type</td>
</tr>
<tr>
<td>17.</td>
<td>Pump weight</td>
</tr>
<tr>
<td>18.</td>
<td>Pump set weight</td>
</tr>
<tr>
<td>19.</td>
<td>Pump size</td>
</tr>
<tr>
<td>20.</td>
<td>Pump Foundation size</td>
</tr>
</tbody>
</table>

### 8. HEATING SYSTEM - HOT WATER GENERATOR

1. **SCOPE**
   
   This section of the specification covers the supply, installation, testing and commissioning of hot water generator along with its accessories, conforming to these specifications and in accordance with requirements of drawings.

2. **CODES AND STANDARDS**
   
   The design, manufacture, testing and performance of the Hot Water Generator shall comply with all currently applicable statues, regulations and safety codes in the locality where it is to be installed. The Hot water generator shall also conform to the latest applicable Indian Standards. Nothing in this specification shall be construed to relieve the contractor of this responsibility.

3. **CONSTRUCTION**
   
   The hot water generator shall be vertical/horizontal type comprising of steel shell, heating elements, controls, control panel, mounting frame etc.

   i. **Shell**
      
      The shell shall be of welded construction, fabricated from 10mm thick MS sheet with electric fusion welded seams & in accordance with ASME Boiler & Pressure Vessel Code, Section IV. The shell shall be complete with baffles to provide adequate velocity to water.
ii. Mounting Frame

The hot water generator shall be mounted on a robust fabricated steel frame of 16 SWG (1.6 mm) MS sheet and complete with hinges, locks to make a compact assembly. The base frame shall be designed & fabricated out of required MS sections and shall be suitable for level foundation.

A drain shall be provided at the lower and outlet and inlet connections with flanges shall be on upper end lower side. Connections for safety wall and controls shall be provided on the top. A required no. of sockets for heater elements shall be provided. The construction shall conform to the Indian standards/international standards.

iii. Heating Element

Sheathed tabular electric resistance type heater elements shall be of approved make and made of chromium coated mild steel mounted in electrically resistant u-tubes and shall be immersion type to be in direct contact with water and connected for equal loading.

i. These shall be easily removable without opening the terminal plates.

ii. Heaters shall be of adequate rating and equally distributed for uniform heat transfer.

iii. No. of Banks

<table>
<thead>
<tr>
<th>Power Range</th>
<th>Minimum Banks</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP TO 75KW</td>
<td>Min. 3 Banks</td>
</tr>
<tr>
<td>UP TO 200KW</td>
<td>Min. 4 BANKS</td>
</tr>
<tr>
<td>ABOVE 200KW</td>
<td>Min. 5 BANKS OR more</td>
</tr>
</tbody>
</table>

Heating elements shall be suitable for 415 V +/- 10%, 3 phases, 50 Hz, AC supply and conforming to IS.4159.

The Hot water generator should have at least 5% spare heater capacity, which can be used in case of failure of running heater.

iv. Control Panel

The control panel shall be fabricated out of 2mm MS sheet built in with the hot water generator.

Microprocessor based step controller with thermistor sensor to control the HWG in stages. Features of this control should include dip switch programming, status LED’s. Step controller shall have built in test mode to verify Load wiring, contactors and stage operations with 1 Sec time delay. A separate power controller shall be provided for proportional control (0-100% load), in between the switching on and off of step control stages for precise temp. control up to 250KW and above 250KW a microprocessor based step controller with thermistor sensor to control the HWG in stages.

The HWG shall be BMS compatible and RS-485 Communication port shall be provided for remote programming and control.

v. Insulation

The hot water generator shall be insulated with 50-mm thick fiberglass of density 32 kg/cu.m. and cladded with 0.63mm thick aluminum sheet on MS frame welded to generator body.

vi. The hot water generator shall be provided with lifting lugs on top for easy transportation and handling.

4. PRESSURE TESTING

The Boiler Shall Be Tested In the factory for leak at a Hydraulic Pressure of 350 psi.
5. **CONTROLS AND ACCESSORIES**

One 100 mm dial type thermometer, mercury in bulb type, at inlet and outlet with tubing. Range of thermometer shall be 0-100 Deg c.

One dial type pressure gauge with globe valve at inlet and outlet of the boiler with tubing. Pressure gauge shall have range of 0-10 kg/sq. cm.

Spring loaded safety valve for pressure relief in case of high-pressure build up in the Hot Water Generator. The outlet of safety valve shall be piped to the nearest drain.

- Inlet and outlet connections with matching flanges.
- Drain connection with 25mm-gate valve.
- De-scaling valve
- Automatic air vent valve
- Step controller.
- High temperature cutout
- Electronic low water level switch.
- Vibration isolators with at least 90% efficiency.

6. **CONTROL PANEL**

The hot water generator shall be provided with electrical control panel, factory mounted directly on mainframe, completely wired and tested. The panel shall conform to Indian I.E rules.

The panel shall be provided with accessories. Conforming to the approved list of makes. The panel shall be suitable for 415 V +/-10%, 3ph, 50 Hz AC electric supply.

The control panel shall comprise of:

(a) Incoming MCCB of suitable rating.
(b) Copper/Al. bus bar of suitable size
(c) Ammeter with current transformers and selector switch.
(d) Voltmeter with selector switch
(e) Contactors
(f) On/ Off indication lamps for individual banks.
(g) Phase indication lamps with control fuses.
(h) Fault indication lamps.
(i) On/Off toggle switch for operating individual banks.
(j) Alarm with reset push button.
(k) Push button for lamp test and heater reset.
(l) Copper connection with cables and control cabling.
(m) Microprocessor based step controller
(n) Hot Water Generators shall be completely BMS compatible having Potential free Dry contacts for:
   i. System On/Off status indication
   ii. Low Water Level Trip
iii. Hi. Temp. Trip
iv. Auto/Manual Selector Mode
v. Start/Stop Command
vi. RS-485 Communication port for remote programming and control

The doors of electrical controls panel shall be openable only when incoming power supply is cut off.

7. **PAINTING**

All external welds should be de-rusted, cleaned and applied with two coats of necessary red oxide primer. Then it shall be powder coated with Siemens grey RAL-7032 shade or as per requirement.

8. **TESTING**

The unit shall be tested at site to ensure the specified output of hot water generator after satisfactory installation.

9. **DATA / INFORMATION:**

The data sheet A, as below, indicates the parameters for manufacture/fabrication of Hot water generator. The contractor shall complete the data sheet B & submit as a part of his technical submittal at appropriate stage.

**HOT WATER GENERATOR - DATA SHEET A**

<table>
<thead>
<tr>
<th>S. N.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Design Features</td>
</tr>
<tr>
<td>1.1</td>
<td>Application</td>
</tr>
<tr>
<td>1.2</td>
<td>Minimum capacity</td>
</tr>
<tr>
<td>1.4</td>
<td>Numbers Required</td>
</tr>
<tr>
<td>2.0</td>
<td><strong>Features of Construction</strong></td>
</tr>
<tr>
<td>2.1</td>
<td>Type</td>
</tr>
<tr>
<td>2.2</td>
<td>Heaters</td>
</tr>
<tr>
<td>3.0</td>
<td><strong>Material of construction</strong></td>
</tr>
<tr>
<td>3.1</td>
<td>Shell</td>
</tr>
<tr>
<td>3.2</td>
<td>Dished ends</td>
</tr>
<tr>
<td>4.0</td>
<td><strong>Insulation</strong></td>
</tr>
<tr>
<td>4.1</td>
<td>Material</td>
</tr>
<tr>
<td>4.2</td>
<td>Thickness</td>
</tr>
</tbody>
</table>
4.3 Density 32 KG / cum
4.4 Finish (0.63 mm) 24 G Aluminium cladding

5.0 Testing
5.1 Hydrostatic test At 350 PSIG for leaks
5.2 Performance test Standard running test

HOT WATER GENERATOR - DATA SHEET B

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Application</td>
</tr>
<tr>
<td>2</td>
<td>Make</td>
</tr>
<tr>
<td>3</td>
<td>Design Capacity KW</td>
</tr>
<tr>
<td>4</td>
<td>Type</td>
</tr>
<tr>
<td>5</td>
<td>Model</td>
</tr>
<tr>
<td>6</td>
<td>Banks No / KW</td>
</tr>
<tr>
<td>7</td>
<td>Vessel size Mm</td>
</tr>
<tr>
<td>8</td>
<td>Thickness</td>
</tr>
<tr>
<td>8.1</td>
<td>Shell (mm)</td>
</tr>
<tr>
<td>8.2</td>
<td>Dished ends (mm)</td>
</tr>
<tr>
<td>9.0</td>
<td>Insulation</td>
</tr>
<tr>
<td>9.1</td>
<td>Material</td>
</tr>
<tr>
<td>9.2</td>
<td>Thickness (mm)</td>
</tr>
<tr>
<td>9.3</td>
<td>Density (Kg/CUM)</td>
</tr>
<tr>
<td>9.4</td>
<td>Finish</td>
</tr>
<tr>
<td>10.0</td>
<td>Dimensions (L x W x H) (mm)</td>
</tr>
<tr>
<td>11.0</td>
<td>Heaters</td>
</tr>
<tr>
<td>11.1</td>
<td>Make</td>
</tr>
<tr>
<td>11.2</td>
<td>Model</td>
</tr>
<tr>
<td>12.0</td>
<td>Electrical Characteristics</td>
</tr>
<tr>
<td>13.0</td>
<td>Test Pressure</td>
</tr>
</tbody>
</table>
9. FLOOR MOUNTED AIR HANDLING UNITS

1. SCOPE

This section of the specification covers the supply, installation, testing and commissioning of double skin construction air handling units along with its accessories, conforming to these specifications and in accordance with requirement of the DBR, Drawings and functional requirement.

2. TYPE

The air handling units shall be double skin modular, draw through type comprising of various sections such as mixing chamber (wherever R.AIR and F.AIR are ducted.), pre filter section, chilled water coil section, fan section supply air plenum as per details given in Drawings and functional requirement.

3. CAPACITY

The air handling capacities, maximum motor HP, static pressure shall be as shown on Drawings and as per requirements.

4. CONSTRUCTION

I. AHU HOUSING / Casing:

i. The AHU housing shall be of double skin construction with main structure made of extruded aluminum hollow sections. The panels shall be double skin sandwich type of required thickness pre painted GSS/ pre-plasticized on the outside and of required thickness galvanized sheet inside with 23/43 mm thick PUF insulation or equivalent material injected in between. These panels shall be screwed with soft rubber gasket fixed in built in groove of aluminum frame in between to make the joints airtight.

ii. Framework for each section shall be joined together with soft Neoprene rubber gasket in between to make the joints airtight. Suitable airtight access doors /panels with nylon hinges and locks shall be provided for access to various sections for maintenance. The entire housing shall be mounted on roller-formed GSS channel framework having pressure die cast aluminum jointers.

II. Drain Pan

The drain pan shall be of 18 G stainless steel (SS-304 grade) with necessary slope to facilitate fast removal of condensate. Necessary arrangement will be provided to slide the coil in the drain pan. The drain pan shall be insulated with 19 mm thick close cell Nitrile insulation (self adhesive)/as per manufacturer's specifications or equivalent.

III. Cooling / Heating Coil

The chilled /hot water coil shall be of seamless copper tubes not less than 0.5 mm thick and 15mm OD. Coil face areas shall be such as to ensure rated capacity from each unit and such that air
velocity across each coil shall not exceed 150 meters per minute. The coil shall be pitched in the
unit casing for proper drainage. The fins shall be spaced by collars forming integral part of the
fins. The tubes shall be staggered in the direction of airflow.

The fins shall be uniformly bonded to the tubes by mechanical expansion of the tube for minimum
thermal contact resistance with fins. Fin spacing shall be 11 to 13 FPI. The coils shall be tested
against leaks at a hydraulic pressure of 21 kg/sq. cm. This pressure shall be maintained for a
period of at least 2 hours. No drop should be observed indicating any leaks. The water headers
shall be of copper with adapter complete with water in / out connections, vent plug on top and
drain at bottom and designed to provide water velocity between 2 to 6 FPS.

IV. Fan Section with DIDW centrifugal Fan or Forward/ Backward/Aerofoil or Plug Type as per
requirements.

DIDW: The fan shall be backward curved, double inlet double width type. The fan shall be
AMCA certified for sound and performance. The wheel & housing shall be fabricated from
heavy gauge galvanized steel. The fan impeller shall be mounted on a solid shaft supported to
housing with spider frame or angle iron frame & pillow block heavy-duty ball bearings. The fan
shall be selected for a highest efficiency, low speed and low noise. The impeller & fan shaft shall
be statically and dynamically balanced. The fan outlet velocity shall not be more than 550 MPM.
Fan housing with motor shall be mounted on a common extruded aluminum base mounted inside
the air handling housing on anti vibration spring mounts or cusdy foot mounts of at least 90%
vibration isolation efficiency. The fan outlet shall be connected to casing with the help of fire
retardant double canvas or Neoprene rubber of imported Origin. The fan shall be selected for a
noise level of less than 75 DB (A) at two meter distance.

PLUG FANS: Fans shall be backward curved plug fan with aerofoil design blades so as to give
maximum efficiency for given duty condition. The fan shall be AMCA certified and the entire Fan
+ Motor assembly shall be balanced before dispatch. Multiple fans / single fan shall be used in
AHU to suit available AHU Room at site & as per approved shop drawing. The supply air fan shall
be as per requirements. The fan impeller shall be supported to housing with angle iron frame &
pillow block heavy duty ball bearing. The fan housing with TEFC Sq. Cage motor shall be mounted
on a common adjustable base frame on vibration isolators / rubber turret mounts vibration
isolators. The fan motor shall be installed inside the housing of air handling unit to keep low noise
level. The fan & motor assembly shall be of aluminum extruded section only.

V. FILTER SECTION

Each unit shall be provided with a factory assembled filter section containing synthetic media
washable air filters with efficiency of 90% down to 10-micron particle size of MERV 8 rating.
Filters shall have aluminum frame. Filter face velocity shall not exceed 150 meters per minute.
Filter shall fit so as to prevent by pass. Holding frames shall be provided for installing number of
filter cells in banks. These cells shall be held within the frames by sliding the cells between guiding
channels.

Wherever fine filters are required to be installed, AHU shall be provided with fine filter sections
with filters in double skinned construction. The frame of fine filters shall be Aluminum anodized. The
media for fine filters shall be non-woven synthetic supported by HDPE mesh on one side &
aluminium expanded mesh on other side. The filtration efficiency shall be as per MERV 13 rating.

5. FRESH AIR INTAKES

Extruded aluminum construction duly anodized fresh air louvers with bird screen and extruded
construction dampers shall be provided in the clear opening in masonry walls of the air handling
unit room having at least one external wall. Fresh air louver, damper, pre filters, ducts and fresh
air fan with speed regulator (wherever specified in DBR) shall be provided. Fresh air dampers
shall be of the interlocking, opposed blade louver type. Blades shall be rattle free. Damper shall
be similar to those specified in 'air distribution'. Fresh air fans and fresh air intakes shall be as per the requirements.

6. **ACCESSORIES**

Each air handling unit shall be provided with manual air vent at highest point in the cooling/heating coil. In addition, the following accessories may be required at air handling units. Their detailed specifications are indicated in individual sections and quantities separately identified in DBR.

   (a) Stem type thermometer at each AHU coil inlet and outlet with tubing and gauge cocks and specification as per the section, ‘Automatic Controls and Instruments’

   (b) Pressure gauge with globe valves at inlet and outlet of each AHU coil with tubing and specifications as per the section, ‘Automatic Control and Instruments’.

   (c) Butterfly valves at inlet and outlet of the each coil.

   (e) Y strainer at inlet of each coil.

   (f) Union and condensate drain piping from the unit up to the drain trap as described in section piping.

   (g) PIB Control Valve located in chilled/hot water lines connected to the coil. This valve shall be operated by the cooling/heating thermostat / humidistat and shall control the flow of chilled/hot water as per section ‘automatic controls and instruments’.

   (h) Cooling/heating thermostat

   (i) Automatic Controls and Instruments shall be located in return air stream.

   (j) Flexible connection between the fan outlet and duct.

   (k) Vibration isolators of at least 90% efficiency.

**I. SAFETY FEATURES**

Each handling unit must have safety features as under:-

   a) The fan access door must have micro switch interlocked with fan motor to enable switching off the fan motor automatically in the event of door opening.

   b) The access door shall further have wire mesh screen as an added feature, bolted on to the unit frame.

   c) Fan and motor base shall be properly earthed from the factory.

   d) All screws used for panel fixing and projecting inside the unit shall be covered with PVC caps to avoid human injury.

7. **MOTOR & DRIVE**

Fan drive shall be 3 phase-squirrel cage totally enclosed fan cooled motor, having efficiency class IE-3, suitable for 415 Volts, 50 Hz AC supply. Motor shall be specially designed for quiet operation and motor speed shall not exceed 1440 RPM & designed for continuous operation duty. Drive to fan shall be provided through belt drive arrangement with required no. of belts for power transmission without slippage. Belts shall be of oil resistant type of approved make only. Direct driven motors may also be used unless otherwise specified.

**DESIGN DATA FOR AIR HANDLING UNITS**

   (a) Fan outlet velocity shall not exceed 500 MPM.

   (b) The air velocity across coil shall not exceed 150 MPM.
(c) The air velocity across air pre filter shall not exceed 150 MPM.

Motor ratings are only tentative and shall be suitable for the duty but not less than the specified HP. The motor shall be selected with a safety factor of at least 20% over and above the brake power.

The AHU fan shall be selected for a total static pressure as indicated in DBR and as per requirements.

8. INSTALLATION

Air Handling Unit shall be installed inside the AHU room to permit the removal of all the parts of AHU for any maintenance work without dismantling other equipment such as plenum, pipes, ducts etc. Air handling unit installation shall be carried out as per manufacturer’s recommendation and mounted on serrated rubber pads. The serrated rubber pads shall be in two layers with 16G GI sheet sandwiched in between.

9. PERFORMANCE DATA

Air handling unit shall be selected for the lowest operating noise level of the equipment. Fan performance rating and power consumption data with operating points clearly indicated shall be submitted and verified at the time of testing, commissioning of the installation.

10. TESTING

Cooling/Heating capacity of various air-handling unit models shall be computed from the measurements of airflow and dry and wet bulb temperatures of air entering and leaving the coil.

Flow measurements shall be by anemometer and temperature measurements by accurately calibrated mercury in glass thermometer. Computed result shall conform to the specified capacities and quoted ratings. Consumption shall be computed from measurements of incoming voltage and input current.

11. DATA / INFORMATION:

The contractor shall complete the Data Sheet & submit as a part of his technical submittal at appropriate stage.

10. HEAT RECOVERY VENTILLATION SECTION: (ENTHALPY WHEEL)

a. Wheel: The wheel shall be made of alternate layer of corrugated and intervening flat composite material of aluminium foil of uniform width to ensure smooth surface. The cross contamination between the two stream shall be nil and leakage less than 0.04%. The wheel medium should be bonded together to form rigid transfer medium forming a multitude of narrow channels ensuring laminar flow. The wheels shall be of proven design.

The wheel can be fully wound or on larger units, sectorised, i.e. assembled in segments. In latter case the segments are assembled between rigid spokes thus ensuring structural longevity and allowing replacement of one or specific segments only.

The wheel shall be cleanable by spraying its face surface with compressed air, low temperature steam or hot water or by vacuum cleaning without affecting its latent properties.

The face velocity across the wheel should not exceed 700 fpm (3.5 m/s).

The wheels shall be tested in accordance with AHRI (Std. 1060) or ASHRAE S4-78 method of testing air to air heat exchangers. Development an manufacturers shall meet all quality assurance criteria specified in BSEN ISO 9001.

The minimum sensible and latent efficiencies should be 75%. A computerized selection should be enclosed along with offer.
b. Casing: The casing shall be constructed as a single skin, self-supporting, galvanized sheet steel structure and include rotary wheel support beams and purging sector. The casing shall be supplied with access panels to facilitate inspection and service. Size 2150 mm and larger shall be in two sections to facilitate shipping and handling.

c. Seals: The casing shall be equipped with adjustable brush seals, which minimize the carryover to max 0.05 – 0.2%.

d. Hub and Spokes: Hub and Spokes on one piece rotor shall be Aluminium and on sectorized rotor Hub shall be made of steel, painted with anti-corrosion paint and galvanized sheet steel spokes.

e. Drive: The wheel shall be belt driven along its perimeter. A constant speed fractional horsepower motor shall be used. The motor shall be mounted on a self-adjusting base to provide correct belt tension.

**TESTING**

The Thermal Wheel shall be tested in accordance with the parameters fixed as below.

- Supply Air Capacity - FDB/FWB.
- Exhaust Air Capacity - FDB / FWB.
- Fresh Air Capacity - FDB / FWB

Heat exchanger units (HRV) in double skin construction, constructed out of extruded Aluminium section frame with puf insulated panels, blowers, IE-3 Motor plate to plate type Aluminium heat exchanger and filters. The unit will have two separate passages one for supply of fresh air and the other for exhaust of cool air from the rooms after the recovery of energy. Efficiency of these heat exchangers shall be 60-65%. The plate to plate heat exchanger shall be rigid thermally bonded seamless Aluminium channels separated by extruded aluminium spacers of the following capacity.

11. **CEILING SUSPENDED AIR HANDLING UNITS**

1. **SCOPE**

   The scope of this section comprises the supply, erection, testing and commissioning of ceiling mounted air handling units, conforming to these specifications and in accordance with requirements of drawings and of the DBR.

2. **TYPE**

   The air-handling units shall be double skin ceiling suspended, draw through type comprising of various sections such as pre-filter section, chilled water coil section, fan section, as per details given in drawings and functional requirement.

3. **CAPACITY**

   The air moving and coil capacities shall be as shown on the drawings and DBR.

4. **UNIT CONSTRUCTION**

   The ductable unit shall be ceiling suspended type. The housing/casing of the air handling unit shall be double skin construction. The framework shall be of extruded aluminum hollow sections. All the frame shall be assembled using pressure die cast aluminum joints to make a sturdy, strong & self-supporting frame work for various sections.

   40mm thick double skin panels shall be made of 0.8 mm pre-plasticized GSS sheet on outside and 0.8 mm galvanized sheet inside with PUF insulation injected in between. These panels shall be screwed on to the framework with soft rubber gasket on aluminium frame to make the joints air tight. Insulation material shall be of 40 Kg./m3 density (minimum). Detachable steel insulated drain pan with necessary slope to facilitate fast removal of condensate shall be provided. Necessary
outlet from the drain pan shall be provided. The unit shall be suitably insulated from inside to avoid condensation on outer surface. Necessary provision for ceiling suspension shall be provided. The drain pan shall be insulated with 19 mm thick closed cell Nitrile rubber or as per manufacturer’s specifications.

5. **FAN AND MOTOR** (DIDW Centrifugal forward curved fans/plug fans as per requirements)

**DIDW**: The fan shall be DIDW centrifugal forward curved fan having single-phase motor as specified. The fan shall be in 100% galvanized construction and shall be statically and dynamically balanced. The fans shall carry AMCA certification.

The fan motor shall be single-phase squirrel cage suitable for 415V +/- 10%, 50 Hz, 3-phase AC supply as specified in DBR and as per functional requirement. Fan and motor may be directly coupled or may be belt driven. Fan outlet velocity should not be more than 10 m/sec. Motor shall be of IE-3 class efficiency.

**PLUG FANS**: Fans shall be backward curved plug fan with aerofoil design blades so as to give maximum efficiency for given duty condition. The fan shall be AMCA certified and the entire Fan + Motor assembly shall be balanced before dispatch. Multiple fans / single fan shall be used in AHU to suit available AHU Room at site & as per approved shop drawing. The supply air fan shall be as per requirements. The fan impeller shall be supported to housing with angle iron frame & pillow block heavy duty ball bearing. The fan housing with TEFC Sq. Cage motor shall be mounted on a common adjustable base frame on vibration isolators / rubber turret mounts vibration isolators. The fan motor shall be installed inside the housing of air handling unit to keep low noise level. The fan & motor assembly shall be of aluminum extruded section only.

6. **COIL**

The chilled water coil shall be of seamless copper tubes not less than 0.4 mm thick and 12mm OD. Coil face areas shall be such as to ensure rated capacity from each unit and such that air velocity across each coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of airflow. The fins shall be uniformly bonded to the tubes by mechanical expansion of the tube for minimum thermal contact resistance with fins. Coil size shall be selected for a max. face velocity of 500 FPM.

Fin spacing shall be 11 to 12 FPI & shall be 0.17 to 0.2 mm thick. The coils shall be tested against leaks at a hydraulic pressure of 21 kg/sq.cm. This pressure shall be maintained for period of at least 2 hours.

No drop should be observed indicating any leaks ,the water headers shall be completed with water in /out connections, vent plug on top and drain at bottom and designed to provide water velocity between 2 to 6 FPS. The coils exceeding 6 rows depth should be in two equal parts.

7. **FILTER**

Each unit shall be provided with a factory assembled filter section containing synthetic media washable air filters with efficiency of 90% down to 10-micron particle size of MERV 8 rating . Filters shall have aluminium frame. Filter face velocity shall not exceed 150 meters per minute. Filter shall fit so as to prevent by pass. Holding frames shall be provided for installing number of filter cells in banks. These cells shall be held within the frames by sliding the cells between guiding channels.

8. **ACCESSORIES**

Each air-handling unit shall be provided with manual air vent at highest point in the cooling coil. In addition; following accessories may be required at air handling units.

a. Stem type thermometer at inlet and outlet of each coil with tubing and gauge cocks and as per applicable specifications .
b. Pressure gauge with globe valves at inlet and outlet of each coil with tubing and as per applicable specifications.

c. Butterfly valves at inlet and outlet of each coil.

d. Y Strainer at inlet of each coil.

e. Union and condensate drain piping from the unit up to the drain trap as described in section piping.

f. PIB Control Valve located in chilled water lines connected to the coil. This valve shall be operated through the cooling/heating thermostat and shall control the flow of chilled/hot water and as per applicable specifications.

g. Cooling/heating thermostat as per section

h. ‘Automatic Controls and Instruments’ shall be located in return air stream.

i. Double Flexible connection of fire retardant Hessian between the fan outlet and duct.

j. Vibration isolators of minimum 90% efficiency.

k. Motor & drive package

l. Air purge valve on top of coil header and drain valve at bottom.

9. DESIGN DATA FOR AIR HANDLING UNITS

i. Fan outlet velocity shall not exceed 550 MPM.

ii. The air velocity across coil shall not exceed 150 MPM.

iii. The air velocity across air pre filter shall not exceed 150 MPM.

Motor rating is tentative only and shall be suitable for the duty but not less than the specified HP. Motors shall be selected considering at least 20% margin over the break power.

The AHU fan shall be selected for a total static pressure as indicated in DBR and its functional requirement.

10. INSTALLATION

Unit shall be installed above the false ceiling in a manner so as to permit the removal of all the parts of AHU for any maintenance work without dismantling other equipment such as plenum, pipes, ducts etc. Air handling unit installation shall be carried out as per manufacturer’s recommendation. Rubber in shear type suspension hangers shall be provided for vibration isolation.

11. PERFORMANCE DATA

Air handling unit shall be selected for the lowest operating noise level. Fan performance rating and power consumption data with operating points clearly indicated shall be submitted and verified at the time of testing & commissioning of the installation.

12. TESTING

Cooling/heating capacity of various air-handling unit models shall be computed from the measurements of airflow and dry and wet bulb temperatures of air entering and leaving the coil.

13. DATA / INFORMATION:-

The contractor shall complete the Data Sheet & submit as a part of his technical submittal at appropriate stage.
### FLOOR MOUNTED

**AIR HANDLING UNITS – DATA SHEET**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GENERAL</td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Manufacturer</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Type of Unit</td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>Over All Dimensions (L x W x H) (mm)</td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>Weight (Including Water in circulation) Kg.</td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>Approximate Noise Level (DBA)</td>
<td></td>
</tr>
<tr>
<td>1.6</td>
<td>Fan Discharge Position</td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td>FAN SECTION</td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Air Quantity (CFM)</td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>Total Static Pressure (mm of WG)</td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>Fan Speed (RPM)</td>
<td></td>
</tr>
<tr>
<td>2.4</td>
<td>Fan Diameter (INCH) and no. Of fans</td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>Balancing (Static and / or dynamic)</td>
<td></td>
</tr>
<tr>
<td>2.6</td>
<td>BHP</td>
<td></td>
</tr>
<tr>
<td>2.7</td>
<td>Motor HP, RPM, Make &amp; Type</td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td>COOLING COIL</td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Coil Fin Material (Aluminum or copper)</td>
<td></td>
</tr>
<tr>
<td>3.2</td>
<td>Tube Diameter (INCH) and material</td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>Water through coil (USGPM) and no. of circuits</td>
<td></td>
</tr>
<tr>
<td>3.4</td>
<td>Fin Size (INCH)</td>
<td></td>
</tr>
<tr>
<td>3.5</td>
<td>No of Fins / INCH</td>
<td></td>
</tr>
<tr>
<td>3.6</td>
<td>Water velocity through Coil (FPS)</td>
<td></td>
</tr>
<tr>
<td>3.7</td>
<td>Water Coil Pressure Drop (ft of WG)</td>
<td></td>
</tr>
<tr>
<td>3.8</td>
<td>Outside Coil Surface (SQFT)</td>
<td></td>
</tr>
<tr>
<td>3.9</td>
<td>Face Area (SQFT) of Coil</td>
<td></td>
</tr>
<tr>
<td>3.10</td>
<td>Rows Deep</td>
<td></td>
</tr>
<tr>
<td>3.11</td>
<td>Water Temperature IN &amp; OUT (DEG F)</td>
<td></td>
</tr>
<tr>
<td>3.12</td>
<td>Air In and Out DB&amp; WB Temp (DEG F)</td>
<td></td>
</tr>
</tbody>
</table>
# CEILING SUSPENDED AIR HANDING UNITS

## DATA SHEET B

<table>
<thead>
<tr>
<th>SECTION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>GENERAL</td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Manufacturer</td>
</tr>
<tr>
<td>1.2</td>
<td>Type of Unit</td>
</tr>
<tr>
<td>1.3</td>
<td>Over All Dimensions (L x W x H) (mm)</td>
</tr>
<tr>
<td>1.4</td>
<td>Weight (Including Water in circulation) Kg.</td>
</tr>
<tr>
<td>1.5</td>
<td>Approximate Noise Level (DBA)</td>
</tr>
<tr>
<td>1.6</td>
<td>Fan Discharge Position</td>
</tr>
<tr>
<td>2.0</td>
<td>FAN SECTION</td>
</tr>
<tr>
<td>2.1</td>
<td>Air Quantity (CFM)</td>
</tr>
<tr>
<td>2.2</td>
<td>Total Static Pressure (mm of WG)</td>
</tr>
<tr>
<td>2.3</td>
<td>Fan Speed (RPM)</td>
</tr>
<tr>
<td>2.4</td>
<td>Fan Diameter (INCH) and no. Of fans</td>
</tr>
<tr>
<td>2.5</td>
<td>Balancing (Static and / or dynamic)</td>
</tr>
<tr>
<td>2.6</td>
<td>BHP</td>
</tr>
<tr>
<td>2.7</td>
<td>Motor HP, RPM, Make &amp; Type</td>
</tr>
<tr>
<td>3.0</td>
<td>COOLING COIL</td>
</tr>
<tr>
<td>3.1</td>
<td>Coil Fin Material (Aluminum or copper)</td>
</tr>
<tr>
<td>3.2</td>
<td>Tube Diameter (INCH) and material</td>
</tr>
<tr>
<td>3.3</td>
<td>Water through coil (USGPM) and no. of circuits</td>
</tr>
<tr>
<td>3.4</td>
<td>Fin Size (INCH)</td>
</tr>
<tr>
<td>3.5</td>
<td>No of Fins / INCH</td>
</tr>
<tr>
<td>3.6</td>
<td>Water velocity through Coil (FPS)</td>
</tr>
<tr>
<td>3.7</td>
<td>Water Coil Pressure Drop (ft of WG)</td>
</tr>
<tr>
<td>3.8</td>
<td>Outside Coil Surface (SQFT)</td>
</tr>
<tr>
<td>3.9</td>
<td>Face Area (SQFT) of Coil</td>
</tr>
<tr>
<td>3.10</td>
<td>Rows Deep</td>
</tr>
<tr>
<td>3.11</td>
<td>Water Temperature IN &amp; OUT (DEG F)</td>
</tr>
<tr>
<td>3.12</td>
<td>Air In and Out DB&amp; WB Temp (DEG F)</td>
</tr>
</tbody>
</table>
12. VARIABLE FREQUENCY DRIVES FOR HVAC SYSTEMS

1. GENERAL REQUIREMENTS
   a. 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.
   b. The frequency converter shall not be a general purpose product, but a dedicated HVAC engineered product.
   c. The VFD and its options shall be factory mounted and tested as a single unit under full load before dispatch.
   d. The VFD shall be tested to UL 508C. The appropriate UL label shall be applied.
   e. The VFD shall be CE marked and conform to the European Union Electro Magnetic Compatibility directive.
   f. The VFD shall be UL listed for a short circuit current rating of 100 kA and labeled with this rating.

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

   When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor’s service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

   2.2 The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.

   2.3 The VFD shall have a dual 5% impedance DC link reactor (harmonic filters) on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable.

   2.4 VFDs with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.

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

   2.5 All VFDs shall contain integral EMC Filters to attenuate Radio Frequency Interference conducted to the AC power line. The VFDs shall comply with the emission and immunity requirements of IEC 61800-3 : 2004, Category C1 with 50m motor cable (unrestricted distribution). The suppliers of VFDs shall include additional EMC filters if required to meet compliance to this requirement.
2.6 The VFD’s full load output current rating shall meet or exceed the normal rated currents of standard IEC induction motors. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 second while starting.

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

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

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

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

2.11 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.

2.12 Galvanic isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete digital I/O shall include additional isolation modules.

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

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

3. **PROTECTIVE FEATURES**

3.1 Overload protection in VFD shall automatically compensate for changes in motor speed.

3.2 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.

3.3 Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.

3.4 Protect from under voltage. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output, without faulting, with an input voltage as low as 70% of the nominal voltage.

3.5 VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.
3.6 If the temperature of the VFD's heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD's temperature becomes too high.

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

3.8 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.

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

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

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

4. INTERFACE FEATURES

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

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

4.3 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.

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

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

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

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

4.8 A Red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.

4.9 A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD. The VFD shall also have individual Fan, Pump, and Compressor menus specifically designed to facilitate start-up of these applications.

4.10 A three-feedback PID controller to control the speed of the VFD shall be standard.
4.11 This controller shall accept up to three feedback signals. It shall be programmable to compare the feedback signals to a common set point or to individual set points and to automatically select either the maximum or minimum deviating signal as the controlling signal. It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.

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

4.13 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.

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

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

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

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

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

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

4.20 VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (°F). Examples can be room temperature in °C, return air temperature in °C, supply air temperature in °C, CO2 concentration in ppm, pressure in bar, differential pressure in PSI etc.

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

4.22 Standard Control and Monitoring Inputs and Outputs
a. Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.

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

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

d. Each relay shall have an adjustable on delay / off delay time.
e. Two programmable analog inputs shall be provided that can be either direct- or reverse-acting.

f. Each shall be independently selectable to be used with either an analog voltage or current signal.

g. 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.

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

i. The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting.

j. One programmable analog current output (0/4 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.

k. It shall be possible to read the status of all analog and digital inputs of the VFD through serial bus communications.

l. It shall be possible to command all digital and analog output through the serial communication bus.

4.23 Optional Control and Monitoring Inputs and Outputs

a. It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.

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

c. The VFD shall automatically recognize the option module after it is powered up. There shall be no need to manually configure the module.

d. Modules may include such items as:

e. Additional digital outputs, including relay outputs

f. Additional digital inputs

g. Additional analog outputs

h. Additional analog inputs, including Ni or Pt temperature sensor inputs

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

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

4.25 A real-time clock shall be an integral part of the VFD.

a. It shall be possible to use this to display the current date and time on the VFD’s display.

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

c. All VFD faults shall be time stamped to aid troubleshooting.

d. It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.

e. The real-time clock shall be able to time and date stamp all faults recorded in the VFD fault log.

f. The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.

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

  ii. Comparators for comparing VFD analog values to programmed trigger values

  iii. Logic operators to combine up to three logic expressions using Boolean algebra

  iv. Delay timers

  v. A 20-step programmable structure

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

5. SERIAL COMMUNICATIONS

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

  a. Metasys N2

  b. Modbus RTU

5.2 VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD. The manufacturer shall provide at no-charge PC software to allow complete setup and access of the VFD and logs of VFD operation through the USB port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.

5.3 The VFD shall have provisions for an optional 24 V DC back-up power interface to power the VFD’s control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.

6. ADJUSTMENTS

6.1 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.

6.2 Four independent setups shall be provided.

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

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

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

If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under-voltage, over-voltage, current limit, over temperature, and VFD overload. The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.

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

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

7. OPTIONAL FEATURES

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

8. SERVICE CONDITIONS

8.1 Ambient temperature at full speed, full load operation with continuous drive rated output current:
   a. -10 to 45°C for ratings upto 90 kW without derating
   b. -10 to 40°C for ratings 110 kW and higher without derating
   c. Relative Humidity : 0 to 95%, non-condensing.
   d. Elevation : Up to 3,300 feet without derating.
   e. AC line voltage variation : + 10% of nominal with full output.
   f. VFD Enclosure protection : IP 55, integral, with no additional cabinets.
   g. Side Clearances : No side clearance shall be required for cooling.
   h. All power and control wiring shall be done from the bottom.
   i. All VFDs shall be plenum rated.

9. QUALITY ASSURANCE

9.1. 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.

9.2. All optional features shall be functionally tested at the factory for proper operation.

13. FILTERS

1. GENERAL

This section covers the general requirements for special type of filters to be installed in air moving equipment or air ducts.

2. 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.

3. **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.

4. **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.

5. **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. **Finished Standard :**
- Epoxy Polyester Powder Coated off white/pure white.
- Natural anodised.

**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
  - EN 1822
  - Eurovent 4/5
  - IEST RP CC 001.3

These filters has 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 aluminium or SS 304 material. It shall be of hi 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 by Contractor.**

14. **PAN TYPE HUMIDIFIER**

1. **HUMIDIFICATION ARRANGEMENT –**

   The humidification arrangement shall be provided by AC contractors (wherever required. This shall consist of the following arrangement.

   **Pan Type Humidifier**

   The pan type humidified shall be constructed from 1 mm thick stainless sheet SS-304 with top cover openable for maintenance. The humidifier shall be complete with quick fill, make up overflow & drain connections. The humidifier shall be insulated with fibre glass of density 32 kg/cm2 & shall be cladled with 22G thick aluminium sheet. The humidifier is divided in two chambers from inside, one bank of heater is always kept on to maintain water temperature between 60 to 70 ºC with thermostat. All controls such as low level cut out, thermostat, float valve shall be provided. It shall be factory wired & tested. The humidifier shall have its own powder coated electrical panel made of 16 G CRCA sheet complete with contactors, MCB Low level cutout, Heating thermostat, fault indicating lamp, high temperature cutout etc. & internally wired.

   The humidifier shall have two chambers with two banks of heaters. One bank of heaters shall always remain ON when the AHU is in operation to maintain the temperature of water between 60 - 70 deg C and the other bank should come on when there is signal from the humidistat for humidification.

   The electric heaters shall be submersible type made out of incloy sheeth and brass/bronze flanges. The heaters shall be of suitable rating to produce instant steam when required.
Controls and accessories:
The humidifier shall be complete with following controls and accessories:

a. Water proof light in the tank
b. Water level indicator
c. Low water level cutoff switch
d. Float valve with bronze ball
e. Make up, quick fill and drain connections
f. Safety thermostats.
g. Fault indication lamp.

15. FAN COIL UNITS – SPECIFICATIONS

1. 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 requirement of the drawings and DBR.

2. TYPE

The fan coil unit shall be horizontal type to be mounted within ceiling space draw 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.

i. Capacity

The air moving and coil capacities shall be as shown on Drawings and as per requirements.

ii. 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.

iii. 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.

iv. 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.

v. 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. (300 psig) 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.

vi. **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.

vii. **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.

viii. **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.

ix. **PAINTING**

The fan coil units shall be powder coated in approved colour.

3. **CONTROLS**

All units shall be complete with following controls

i. PIB Control Valve in water lines

ii. Wall mounted thermostat containing three speed and on/off control for fan, speed and temperature control for summer/ winter air conditioning

iii. 'Y' strainer, ball valve and globe valve as shown on drawings and as per requirements.

4. **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.

5. **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.

6. **DATA / INFORMATION:-**

The contractor shall complete the Data Sheet & submit as a part of his technical submittal at appropriate stage.

### CEILING MOUNTED FAN COIL UNITS

#### DATA SHEET B

<table>
<thead>
<tr>
<th>GENERAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Manufacturer</td>
</tr>
<tr>
<td>1.2 Type of Unit</td>
</tr>
<tr>
<td>1.3 Over All Dimensions (L x W x H) (mm)</td>
</tr>
<tr>
<td>1.4 Weight (Including Water in circulation) Kg.</td>
</tr>
<tr>
<td>1.5 Approximate Noise Level (DBA)</td>
</tr>
<tr>
<td>1.6 Fan Discharge Position</td>
</tr>
</tbody>
</table>

#### FAN SECTION

| 2.0 |
| FAN SECTION |
| 2.1 Air Quantity (CFM) |
| 2.2 Total Static Pressure (mm of WG) |
| 2.3 Fan Speed (RPM) |
| 2.4 Fan Diameter (INCH) and no. Of fans |
| 2.5 Balancing (Static and / or dynamic) |
| 2.6 BHP |
| 2.7 Motor HP, RPM, Make & Type |

#### COOLING COIL

| 3.0 |
| COOLING COIL |
| 3.1 Coil Fin Material (Aluminum or copper) |
| 3.2 Tube Diameter (INCH) and material |
| 3.3 Water through coil (USGPM) and no. of circuits |
| 3.4 Fin Size (INCH) |
| 3.5 No of Fins / INCH |
| 3.6 Water velocity through Coil (FPS) |
16. **EVAPORATIVE COOLING UNIT - DOUBLE SKIN (AIR WASHER)**

1. **TYPE**
   The evaporative cooling unit shall be double skin construction draw through type comprising of various sections such as filter section, humidifier section, supply air fan section, fine filter plenum, factory fabricated (wherever required) as per details given in Drawings and DBR.

2. **CAPACITY**
   The cooling capacities, motor HP, static pressure shall be as shown on Drawings and in DBR.

3. **CONSTRUCTION**
   i. **HOUSING/CASING**
      The housing /casing of evaporative unit shall be of double skin construction. The framework shall be of extruded aluminum hollow sections. The entire frame shall be assembled using pressure die cast aluminum joints to make a sturdy, strong and self-supporting framework for various sections.

      25 mm thick double skin panel shall be made of 0.6 mm plasticized /pre coated PVC sheeted GSS on outside and 0.6mm galvanized sheet inside with PUF insulation injected in between. These panels shall be screwed on to the framework with soft rubber gasket fixed in built in groove of aluminum frame in between to make the joints airtight.

      Framework for each section shall be joined together with soft rubber gasket in between to make the joints airtight. Suitable airtight access doors/panels with nylon hinges and locks shall be provided for access to various sections for maintenance. The entire housing shall be mounted on extruded aluminium channel framework having pressure die cast aluminium joints.

   ii. **DRAIN PAN**
      Drain pan shall be constructed of 18 G stainless steel (SS-304 Grade) with necessary both way slope to facilitate fast removal of drain water.

   iii. **MOTOR DRIVE**
      Fan motors shall be suitable for 415(+/-) 10% volts, 50 Hz, 3 phase, squirrel cage, totally enclosed fan cooled with IP-55 protection. Motor shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt drive arrangement or directly coupled/driven. Belts shall be of oil resistant type. Motors shall be preferably of efficiency class IE-3.

   iv. **FAN**
      The fan shall be backward curved, double inlet, double width type. The wheels and housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on a solid
shaft supported to housing with angle iron frame and pillow block heavy-duty ball bearings. The fan shall be selected for a noise level less than 75-DB (A), at a distance of 2 m.

The impeller & fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 9/10 m/sec. Fan housing with motor shall be mounted on a common extruded aluminium base mounted inside the housing on anti vibration mounts. The fan outlet shall be connected to casing with the help of double fire retardant fabric acting as a flexible connection for anti vibration.

v. WET DECK HUMIDIFIER

Wet deck humidifier pads shall be of cellulose paper minimum 200 mm deep to provide at least 90% saturation efficiency at 2.5 MPS or less air face velocity. The cellulose paper pads shall be housed in a galvanized steel casing complete with water distribution header and interconnecting heavy duty flexible PVC / GI pipes between pump and distribution header.

vi. WATER CIRCULATING PUMPS

Water circulating pumps shall be vertical type. The suction portion shall be at the bottom with proper seal arrangement to directly pick up water from the stainless steel drain pan. The pump shall be suitable to operate at 415(+/-) 10%V, 50 Hz AC supply.

Necessary water bleeding arrangements shall be incorporated with separate drain connection provided in the stainless steel drain pan to bleed small percentage of total circulated water in order to ensure compulsory water change over during running of the system.

vii. FILTERS

Each unit shall be provided with a factory assembled filter section containing washable air filter having bonded expanded aluminium media with aluminium frame. Filter media and frame shall be rust proof and corrosion resistant. Filter face velocity shall not exceed 150 meter per minute. Filter shall fit so as to prevent by pass. Holding frames shall be provided for installing a number of filter cells in banks. These shall be held with in the frames by sliding the cells between guiding channels.

viii. FRESH AIR INTAKES

Anodized extruded aluminium construction (20 microns and above) fresh air intakes louvers with bird screen and extruded aluminium low leakage construction damper shall be provided for FA. Blades shall be made of extruded aluminium. Construction shall be rattling free. Fresh air fans and fresh air intakes shall be as per the requirement.

ix. SAFETY FEATURES

Each evaporative unit must have following safety features:-

i. The fan access door shall be equipped with micro switch interlocked with fan motor to enable switching off the fan motor automatically in the event of door opening.

ii. The access door shall further have wire mesh screen as an added safety feature bolted on to the unit frame.

iii. All screws used for panel fixing and projecting inside the unit shall be covered with PVC caps to avoid human injury.

x. PERFORMANCE DATA

Evaporative cooling units shall be selected for optimum operating noise level. Fan performance rating and power consumption data with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the system.

xi. TESTING
Performance of evaporative cooling unit shall be computed from the measurements of air flow and dry and wet bulb temperature of air entering and leaving the unit. Flow measurements shall be by an anemometer and temperature measurements by accurately calibrated electronic instrument.Computed result shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

17. **KITCHEN EXHAUST SCRUBBER – DRY SCRUBBERS (PROPOSED IN THE CURRENT SCHEME)**

1. **SCOPE**
   The scope of this section comprises the supply, erection, testing and commissioning of dry scrubbers comprising of electrostatic sections with auto wash module for use in kitchen exhaust / grease / exhaust air treatment.

2. **TYPE**
   The unit shall be CE certified and of the type as indicated on Drawings and identified in DBR.

3. **CAPACITY**
   The air-moving capacity of unit shall be as shown on Drawings and in DBR.

4. **TECHNICAL PARAMETERS**
   The unit shall provide efficiency of 90% or better for single pass base on ASHRAE test method at flow rates of 800 – 1500 CFM per module (supported by sample test report by a US laboratory). Multiple units can be joined together for increased volume. The system shall be suitable to connect to fan section with average velocity of 500 FPM across air cleaner.

5. **EQUIPMENT SPECIFICATIONS**
   The unit shall be designed and constructed and supplied by a manufacturer specializing in the research, design and manufacture of products specified in this section with a minimum of three years of documented experience, and capable of issuing complete catalog data on the total product.

6. **UNIT HOUSING**
   Housing shall be 1.4mm thick galvanized steel sheet construction to protect against rust and corrosion. Each section shall include single door access, located one side of the unit. The access door shall be mounted on steel hinges and secured with adjustable, gasket sealed lever latches allowing for component access and removal. All doors shall be gasketed to prevent air and water leakage. Doors to charged high voltage components shall be equipped with electrical interlocks, for interconnection into the primary power supply, to prevent access when the components areenergized. The housing shall be furnished completely assembled for ease of shipment and installation. Between each section, a permanent 1/8‖ thick gasket shall be installed to prevent leakage. The bottom drain pan under ESP section containing integral washing systems shall be pitched downward 1/4‖ per foot minimum toward a 3‖ NPT drain nipple.

7. **BASE CONSTRUCTION:**
   The sections are to be mounted on a structural C-channel or floor mounting or ceiling suspension. Lifting lugs shall be incorporated in the base channel to allow for rigging, if ordered.

8. **FINISH**
   The external casing finish shall be a durable industrial grade semi gloss baked-on epoxy ester, not less than 3 mil minimum thickness.

9. **CELLS WASH MODULE**
The Cells Wash module shall incorporate mechanical filtration. The stationary filter from the direction of airflow will be a metal mesh filters with single, gasketed access doors. Wash manifolds and headers are supplied to wash the module during the normal wash cycle.

10. ELECTROSTATIC PRECIPITATOR MODULE:
The electronic air cleaner shall be the two-stage dual voltage plate type cells, rated at not less than 90% efficiency as per the ASHRAE test standards for dry particulate (supported by sample test report by a US laboratory). The collection cells shall be in Single Pass arrangement to provide for maximum collection efficiency.

11. IONIZING COLLECTION CELL
Ionizing-Collecting cell(s) shall be of one-piece construction more than 13.3 inches deep in direction of airflow. All support framing, end plates and ionizer ground electrodes shall be 0.090 inch thick aluminum. Both repelling and collector plates shall be 0.020 inch thick aluminum, 9.125 inch deep in direction of airflow and rigidly retained in place with tubular spacers and tie rods. Spacing between plates shall be no less than 0.175 inch. Ionizing electrodes shall be tungsten material wire 24 gauge stainless steel spiked design, rigidly supported both vertically and laterally. High voltage support insulators shall be of self-glazing Teflon with all surfaces, including center hole, glazed to enhance dielectric strength and retard tracking. Insulators shall be mounted out of the airstream, to reduce contaminant buildup. All high voltage electrical connections within each tier of cells, shall be between cells and automatically made when cells are installed. All electrical connections between unit tiers and high voltage connections between power packs and cells shall be located on the access door end of the cabinet and manually connected for ease of service. Each cell shall weight not more than 16 kg with atleast 9 ionizing wire and with maximum number of collection/repelling plates up 59 numbers per ESP cell. Minimum collection plate area per 1000 CMH of air flow through ESP Cell shall be 2.0 sqm.

12. POWER SUPPLIES
Power supplies shall be 100% solid state, CE/UL Listed. operate on 200 to 240 VAC, 50 HZ, 1 Phase input and provide a dual high voltage output of (+) 12 to 13 KVDC for the ionizer and (+) 6.0 to 6.5 KVDC for the collector. A regulated output of up to 5.5 MA shall be supplied to maintain the specified collection efficiency. Integrally mounted electrical interlocks shall be provided to prevent access to the high voltage components without first interrupting the primary input power. The power supply shall operate over a temperature range of -32 degrees F to 140 degrees F, be self-protecting and accommodate an LED light indicating the performance status of the ionizing/collecting cell. High voltage output leads shall be sealed and a bleed resistor incorporated to remove stored electrical charge where the power supply(s) are de-energized. Module of capacity above 3000 CFM shall be equipped with Pulse width modulating (PWM) to maintain the specified collection efficiency by maintaining a constant charge in the event of Low/High Voltage from source thus ensuring that the unit functionality is not affected with these voltage fluctuations. Power Consumption should not be more that 50 watts per ESP cell.

All power supply components shall be designed for ease of mounting and servicing. High voltage power cables shall be of one continuous length, splicing is not acceptable.

13. SYSTEM CONTROLS
Programmable Logic Controller (PLC) shall be housed in a NEMA-12 type enclosure. Controller shall be shipped for remote mounting and must be installed indoors or other means of weather protection provided if installed. Terminals shall be provided to interconnect the system fan and shall sequence the detergent wash, soak, rinse fan force dry and return to operation cycle. All sequence times shall be factory set. Control initiation shall be semiautomatic, push button initiated, or fully automatic by time clock, with semiautomatic push button override.
A remote mounted Sleep Mode Reset Switch (momentary contact push button type) shall be supplied to be installed at the kitchen hood location to re-energize the air cleaning system after the wash system has completed. The switch may optionally be installed on the panel of the ATS control enclosure.

14. **STATIC PRESSURE DROPS**

The pressure drop shall not exceed the following (inches H2O):

- ESP Section: 0.14"
- Metal Mesh prefilter or after filter: 0.10"

The ESP section must have both an internal prefilter and an after filter, select and add for each.

External losses for ductwork, exhaust hoods, manufacturing equipment with associated entry losses, kitchen hoods, etc., must be added with the above internal equipment losses to calculate total fan static pressure required.

15. **BMS INTERFACE**

The power supply (pack) shall have a 2 wire dry contacts (NO/NC) for remote link to Building Management System. This is for performance indication of the air cleaning system. Should there be a fault or if service is required, the dry contacts close and a signal is sent to the building BMS System. Should there be multiple units, all the dry contacts can be looped into a set of signal. This ensures proper monitoring of the status of each unit.

18. **WET SCRUBBER (IN ANY OTHER AREA OTHER THAN KITCHEN AS REQUIRED)**

1. **SCOPE OF WORK**

The specification for package type double skin scrubber for mechanical ventilation covers the design requirement, constructional feature, supply, installation, testing & commissioning.

2. **TYPE**

The scrubber shall be double skin spray type system & shall be draw through type.

3. **HOUSING**

Double skinned panels shall be 25 mm thick made of galvanized steel, pressure injected with foam insulation (density 40 Kg / m3) shall be fixed to 1.5 mm thick aluminium alloy twin box section structural framework with stainless steel screws. Outer sheet of panels shall be made of galvanized pre-plasticized sheet of 24 gauge thick and inner sheet of 22 gauge plain GI sheet. The entire framework shall be mounted on an aluminium alloy or galvanized steel (depending on size) channel base as per manufacturer’s recommendation. The panels shall be sealed to the frame work by heavy duty ‘O’ rings gaskets held captive in the framed extrusion. All panels shall be detachable or hinged. Hinges shall be made of die cast aluminium with stainless steel pivots, handles shall be made of hard nylon and be operational from both inside and outside of the unit.

Units supplied with various sections shall be suitable for on site assembly with continuous foam gasket. All fixing and gaskets shall be concealed. Units shall have hinged, quick opening access door in the fan section and also in filter section where filters are not accessible from outside. Access doors shall be double skin type. Recirculation tank shall be fabricated from 18 gauge stainless steel sheet duly reinforced with all corners welded. The tank shall be complete with double brass strainers, make-up connection with float, drain and overflow connections.

4. **FAN**

The blower shall be Centrifugal Forward / Backward Curved DIDW fan wheel of totally GI Construction with Inlet Cones and shall be complete with individual motor and drive and shall be
mounted on C Channel frame and Cushy Foot or Spring Mounts. Each Scrubber shall comprise of one / two no. fans to handle air quantities. Each fan shall be driven by suitable HP TEFC motor. The fan wheel will be of the multiblade type and mounted on two self-aligning pillow block bearings of the requisite size. The fan shall be run with the help of “V” Groove drives as per the recommendation of the drive supplier.

5. **MOTOR**

The TEFC motor shall be suitable for 415 ± 10% volts, 3 phase, 50 Hz ± 5%, A.C supply. The motor shall be with class B/E insulation confirming to IS 325. The motor speed shall be 1440 RPM maximum designed and guaranteed for continuous operation at the nameplate rating. It should confirm to IP 55.

6. **FILTER SECTION**

Filters section shall incorporate metallic viscous filter (for removal of oil and grease) of thickness 50 mm in suitable aluminium frame. Velocity of air across the filters shall not exceed 2.5 m/s.

7. **SPRAY ARRANGEMENT**

The wet section will have 18 G SS Tank and body with folded construction with the bolted openable sides also in 18 G GI sheet. Spray arrangement shall be 2 bank air washer with 1/8″ (3 m) bore bronze nozzles with brass plug complete with GI pipes and spray headers. Minimum number of nozzles shall be 1 / sqft of face area. Face velocity not to exceed 500 FPM (2.5 m/s). PVC drain/overflow and bleed off outlet are to be provided on all wet sections.

8. **PUMP**

The unit will have a single phase 220 volts + 10% 50 c/s power supply monoblock self priming pump assembly to provide recirculated tank water and a pressurized flow via a piping system for proper water distribution. The pump capacity will be such that it can take care of the bank of Nozzles provided and the rigid media.

9. **INSTALLATION**

The fans, pumps, scrubber etc. shall be provided with necessary vibration isolation cushy foot mounts. All necessary accessories such as nut bolts etc. shall be arranged by the contractor. The contractor shall arrange his own labour with material for completion of assembly.

The contractor, if specifically specified in DBR, shall cast the RCC foundations for equipments. Anti-vibration pads of adequate efficiency shall be provided.

10. **TRANSIT DAMAGE**

The contractor at his own cost shall restore the unit to original conditions in case of any damages.

11. **TESTING**

The AC contractor shall compute the unit air quantity with the help of velocity meter. The computed results shall be tallied with specified capacities and power consumption shall be tallied with the indicated figures in the technical data furnished by the contractor.

All necessary instruments of proper accuracy and services needed for the tests required for the computation of capacities and power consumption as required by the Consultant shall be provided by the contractor at his own cost.

It shall also be the responsibility of the Contractor to supply the motors and starters to satisfy the local regulations pertaining to the limitation of starting current and indemnify the Department from all liabilities arising out of any objections raised by the local authorities in this regard.
19. **INLINE & PROPELLER FANS**

1. **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 DBR.

2. **TYPE**

   Centrifugal and inline fans shall be of type as indicated in drawings and in DBR.

3. **INLINE FANS**

   Inline fan shall incorporate SISW direct driven centrifugal fan with TEFC (IP-44) motor. 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.

4. **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:

   a. Wire guard and bird-screen
   b. Gravity louvers at outlet
   c. Regulator for controlling fan speed for single-phase fan motor.
   d. Single-phase preventors for 3 phase fans.
   e. Wiring between regulator and fan motor including termination at both ends.

5. **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.

6. 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.

20. FAN SECTIONS

1. 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 DBR. Fan Outlet velocity shall not exceed 610 meters per minute.

2. TYPE

Ventilation fan sections shall be complete with Centrifugal Fans, belt driven fans complete with motor drive and housing with weatherproof cowl.

3. 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 DBR 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.

4. VIBRATION ISOLATION

The motor and fan assembly shall be isolated from base through Dunlop/Resistoflex vibration isolators.

5. 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.
6. 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.

21. AXIAL FLOW FANS

1. 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 DBR and drawings.

The fans shall be complete with all the accessories required for proper installation and performance consisting mainly of the following:

a. 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).

b. Gravity louvers

2. APPLICABLE SPECIFICATIONS STANDARDS AND CODES.

Documents listed below should be read along with the technical data given in the DBR and shall be applicable to the material, manufacture, testing and installation of axial flow fans and accessories.


b. ANSI/ASHRAE: standard 51

c. ANSI/AMCA: standard 210 & 300 for preparing performance curves, charts and testing of fans for air and sound performance

d. IS-2312 – Propeller type A.C ventilation fans

e. BS – 848/ ACMA Tested – Methods of performance test for fans

3. DESIGN & MANUFACTURING

i. Fan and Components

a. 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 at operating conditions and shall have performance characteristics to match the approved performance curves.

b. 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.

c. 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.

4. 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 DBR. 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.

5. 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.

6. GENERAL REQUIREMENTS
a. 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.

b. NOISE LEVEL: The tendered shall indicate the noise level generated by the fan/motor unit in terms of decibel units to be measured at 3M from the unit. This shall fall in line with best engineering standard and shall not be more than 80 db.

7. PAINTING
All fans and their accessories shall be painted with two coats of suitable enamel paint after one coat of Red Oxide primer.

8. 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.

9. INSPECTION & TESTING
All fans shall be subjected to inspection and testing requirements as given below. The contactor 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.

a. 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.

22. VAV TERMINAL BOXES
1. GENERAL
All the VAV Terminals shall be Pressure Independent type with Direct Digital Controls to regulate the primary air flow rate between the scheduled minimum and maximum values to achieve the specified comfort level within acceptable noise criteria. A separation shall be made in Induction VAV Terminals and Standard VAV Terminals as detailed in the schedule.

The Induction VAV Terminals shall induce room air, without need of an assisting fan, and mix it with conditioned primary air, maintaining a near constant air volume to the room thus providing sufficient air movement necessary to maintain occupant comfort even in extreme load variations.

The VAV terminal shall have the controls, actuators and transformers, etc. pre-fitted, wired and calibrated at the factory and supplied with its appropriate digitally communicating thermostat. The supply of the VAV Terminals and the VAV controls, as well as the commissioning at the site, shall be done by the same specialist/local supplier.

2. CONSTRUCTION OF STANDARD PRESSURE INDEPENDENT VAV TERMINALS

The casing shall be a double wall construction made from galvanized sheet steel (non spiral). Casing Leakage Rate shall be according to class II, VDI 3803/DIN 24 194. The insulation thickness shall be 25 mm. and the insulation material shall be fully enclosed by the metal casing. VAV Terminals with insulation materials in direct contact with the air flow will not be accepted.

The VAV Terminals shall have a low leakage, sandwich construction damper blade with SBR gasket and a solid aluminum damper shaft (diameter 12 mm.) with self lubricating Nylon bearings. The leakage shall be less than 2% of the nominal flow at 750 Pa. inlet static pressure. The duct sleeve connections at the inlet and outlet of the VAV Terminal shall be conform DIN 24 145 or DIN 24 146 respectively.

For large air volumes, Rectangular VAV Terminals shall be provided. These Rectangular VAV Terminals shall have a multi-leaf opposed blade damper with aluminum, aerofoil blade construction, width 50 mm. and external linkage. The damper spindle shall be made of steel (10 mm. diameter), rotating in self lubricating Nylon bearings. The VAV Terminal shall have 30 mm. flange connections at the inlet and outlet of the terminal.

Each VAV Terminal, Circular or Rectangular shall be factory fitted with a multipoint, averaging air flow sensor in the inlet of the terminal. This air flow sensor shall amplify the air pressure signal linearly with an amplification factor of at least 2.0. The air flow sensor shall contain not less than 4x12 sensing points, which shall be arranged in two perpendicular axis of sensing. The holes shall be arranged in such a way that each four points in a ring sense the air pressure across concentric circles of equal area in a round duct. The signal shall be averaged and measured from the center of the sensor. And the accuracy shall be within 2.5% even with irregular duct approach.

3. CONSTRUCTION OF INDUCTION VAV TERMINALS (PRESSURE INDEPENDENT)

The casing shall be rectangular type made from galvanized sheet steel (thickness 1.25 mm.) with a circular inlet, two Induction openings at the sides of the terminal and a rectangular outlet. The duct sleeve connections at the inlet and outlet of the VAV Terminal shall be conform DIN 24 145 or DIN 24 146 respectively. The VAV Terminal shall have internal insulation (thickness 25 mm.), tested HF-1 (UL 94) flame test and erosion proof up to 50 m/s air velocity.

The terminals shall be fitted with a specially constructed jet-tronic damper to regulate the primary air flow between the scheduled minimum and maximum values. The same damper shall also generate and control the Induction effect through the acoustically lined induction chamber of the VAV Terminal. The damper shaft shall be solid aluminum (diameter 12 mm.), rotating in self lubricating Nylon bearings. The damper shall permit proper operation of the terminal over a range of 20 to 100% of maximum flow without the requirement of special VAV diffusers or assisting fans.
23. **AUTOMATIC CONTROLS AND INSTRUMENTS**

1. **SCOPE**

   The scope of this section comprises the supply, installation, testing and commissioning of automatic controls and instruments conforming to these specifications and in accordance with requirement of drawings and in DBR.

2. **PRODUCTS**

   i. **2 WAY MODULATING / PRESSURE INDEPENDENT/ BALANCING and FLOW CONTROL VALVE.**

      The Self balancing flow control valves that are pressure independent, 2-way, modulating to accept input signals from the control system. Each Air Handling Unit / Fan Coil Unit shall be provided with a 2Way Pressure Independent Balancing and Control Valve integrated in a single Body. The valve should be a **Globe Type. Rolling Diaphragm based delta p controller should ensure 100% valve authority.**

      Each air-handling unit/ fan coil unit shall be actuated by a space thermostat. Space conditions shall be maintained by continuous proportional modulation of the chilled/hot water through the coil. Control - Valve should be equipped with electronic modulating gear type (not thermal/wax) actuator which can accept either “4(0)-20 mA / 2(0)-10V DC signals. Operating voltage for actuator shall be 24V AC.

      Minimum Pressure Drop across the valve must not exceed 30 kPa in bigger Sizes. All Valve actuators should be microprocessor based with self-calibrating feature. Valve Actuator combination should be able to give logarithmic control. Actuator shall be able to work against pump head or maximum closing pressure Manual Override Flow Balancing should only be done in Valve, not in actuator Balancing – Each Valve should have a stepless adjustable maximum flow limitation as per the designed flow rate of coils. The balancing should be done only in the valve not in the actuator so that in case of actuator failure the balancing is not lost and easily accessible. For Test ports valve shall have Needle measuring nipple.

      Two way or Three-way motorized valve for each fan coil unit shall be provided in chilled water lines at each fan coil unit as shown on Drawings and included in DBR. The valve shall be actuated by space thermostat. Constant space conditions shall be maintained by allowing all of chilled water to either pass through the coil or bypass the coil and mix with the chilled water return. The valve shall revert to fully bypass position when fan is shut off.

      Valve shall be similar to Honeywell two-position diverting valves 15 cm (1/2 inch) diameter with flare connection. Valve shall be selected for water flow rate of 5-6 USGPM. Pressure drop across the valve shall not exceed 2 psi. Valve shall have the facility to replace motor & actuator without removing the valve body.

   ii. **Flow switches shall be provided in the condensing water line (outlet) and chiller water line (outlet) only near the chilling machine. The control supply of chilling units shall be interlocked with these flow switches.**
iii. Thermostats shall be electrical mode, fixed differential type with sensing element located in the return air stream.

iv. Proportional control thermostats for air conditioning application for actuating the two ways or three way modulating valve at each air-handle units, as shown on drawings and included in DBR. Range shall be 56-84 degree F, differential shall be 3 degree F.

v. SNAP acting fixed differential thermostat for FCU shall be with temperature range of 13-29 degree C differential 37 deg C with ON/OFF, HI/LOW fan switch; normal-cool setting switching off must break fan circuit.

3. INSTRUMENTS

i. Thermometer: Thermometers shall be dial type 100 mm dia or V form industrial type. Body shall be aluminum alloy, anodized gold colored surface. The casing shall be adjustable side ways for reading from the front. The glass capillary shall be triangular in shape with blue mercury filled in glass for better visibility. Scale of reading shall be of the range 0 deg C to 60 deg C & +32 deg F to 150 deg F. Graduation of scale shall be 1 deg in both readings. Ranges of scales shall be 30-90 degrees F (0-50 deg C) for all conditioning applications of cooling only.

Thermometer shall be suitable for 15mm connection. Thermometer for chilled water shall be with long stem so that thermometer is removable without damaging the insulation ms socket to be welded on pipes shall be provided with thermometer. Thermometer shall be installed of chilled water supply and return at each air handling unit, supply and return of each chiller, condenser.

ii. Pressure gauge: shall be installed on suction header and at discharge side of each pump in the chilled water supply and return at each air handling unit, at inlet and outlet of each chiller. Suction side gauge at pump suction header shall be compound gauge with 150 MM dia, range 75 cm vacuum to 10 kg pressure. Discharge side gauge at pumps and at all other locations shall be 150mm range 0-10 kg per sq cm (0-150 PSI) Pressure.

iii. Thermostats

Thermostats shall be electric fixed differential type as indicated below, with sensing element located in the return air stream. All thermostats shall be supplied with the standard mounting boxes as recommended by the manufacturer. The profile, mounting arrangement and exact location of the thermostat shall be such as to suit the site.

I) Proportional control thermostats shall be provided for actuating the three way modulating valve at each air handling unit. Thermostat shall provide manual switching (heat-off-cool-in heating-cooling system).

II) Snap-acting fixed differential type thermostat for actuating the three-way diverting valve at each fan coil unit.

Thermostat shall have temperature adjustments WARM-NORMAL-COOL settings and fan switch. Switching off must break fan circuit.

III) Snap-acting fixed differential heating thermostat for electric winter heating and reheat applications for putting on/off power supply to electric heating or reheat coils in air handling units.

IV) Safety thermostat shall be provided for electric winter heating and reheat application for cutting off power supply to strip heaters in case air flow across strip heater is not established.

V) Air-stat shall be provided within air handling unit containing electric heating or reheat coils to prevent heaters from energizing unless the air flow is established.

iv. Humidistats

Humidistat shall be provided with air handling unit for areas, which require humidity control. One humidistat shall activate the reheat coils in case the space humidity rises beyond the preset limit.
Another humidistat shall energize the humidifier when the humidity falls below the preset limit. These humidistats shall also de-energize these devices when the desired humidity is reached. Humidistats shall be snap-acting type having humidifier/dehumidifier control from 20-80 percent relative humidity, with differential of 5 percent. Humidistat shall have nylon element with three bobbins, and removable knob to prevent tempering of set point.

v. **AUTOMATIC BALANCING VALVES** for Chiller/condenser line: Size : 100-1000 mm size

**AUTOMATIC BALANCING VALVES** WAFER type Valve shall consist of a dynamic, flow limiting device.

VALVE housing shall be constructed of ductile iron ASTM A536, Class 60-40-18; rated at no less than 3400 kPa static pressure at +175°C; shall have single or multiple, parallel-installed stainless steel cartridge assemblies (Flow regulation unit assembly shall be manufactured of stainless steel and stainless steel spring,.) to provide rated flow rate.

- Valve shall be permanently marked to show direction of flow.
- Dual pressure/ temperature test plugs for verifying accuracy of flow performance shall be provided for all valve sizes.
- Flow regulation unit shall be available in four different kPa operational ranges; minimum range shall be capable of being activated by minimum 10kPaD; and shall be capable of controlling flow within +/-5% of rated flow.
- Identification tag shall be available for all valves; tag can be indelibly marked with model number, flow rate.

24. **SHEET METAL WORKS AND ACCESSORIES - (MANUAL FABRICATION)**

1. **SCOPE**

The scope of this section includes supply, fabrication, installation & testing of all sheet metal ducts, supply, installation, testing & balancing of all grills & diffusers as per specifications & drawings.

Except as otherwise specified all ductwork and related items shall be in accordance with these specifications.

Duct work shall mean all ducts, casings, dampers, access doors, joints, stiffeners, hangers & all accessories.

2. **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.

i. 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.

ii. 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</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>751-1000</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>
</tbody>
</table>
### Installation

#### iii. Ducts larger than 450 mm shall be cross broken, duct sections up to 1200 mm length may be used with bracing angles omitted.

#### iv. 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.

#### v. 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.

### 3. INSTALLATION

#### i. All ducts shall be fabricated and installed in workman like manner, generally conforming to relevant BIS codes. Round exposed ducts shall be die formed for achieving perfect circle configuration.

#### a. Ducts so identified on the drawing shall be acoustically lined and thermally insulated as described in the section ‘Insulation’ and as indicated in DBR. Duct dimensions shown in drawings are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in DBR.

#### b. Ducts shall be straight and smooth on the inside with neatly finished joints. All joints shall be made airtight.

#### c. All exposed ducts upto 60 cm width within conditioned spaces shall have slip joints. The internal ends of the slip joints shall be in the direction of airflow. Ducts and accessories within ceiling spaces visible from air-conditioned areas shall be provided with two coats of matt black finish paint.

#### d. Change in dimensions and shape of ducts shall be gradual. Air turns shall be installed in all vanes arranged to permit the air to make the turn without appreciable turbulence.

#### e. Ducts shall be fabricated as per details shown on drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees of ample size to keep the ducts true to shape and to prevent buckling, vibration or breaking.

#### f. All sheets metal connections, partitions and plenums required to confine the flow of air to and through the filters and fans shall be constructed of 18 Gauge GSS thoroughly stiffened with 25mm x 25mm x 3mm angle iron braces and fitted with all necessary inspection doors as required to give access to all parts of the apparatus. Doors shall be not less than 45cm X 45cm in size.

#### g. Plenums shall be panel type and assembled at site. Fixing of MS angle iron flanges of duct pieces shall be with rivet heads inside i.e. Towards G.S. sheet and riveting shall be done from outside.

#### h. Rubber gasket 3 mm thick shall be used between duct flanges and between duct and duct supports instead of felt in all ducting installation for complete sealing.

#### ii. During the construction, the Contractor shall temporarily close duct openings with sheet metal covers to prevent debris-entering ducts and to maintain opening straight and square, as per direction of Engineer-in-Charge.
a. Great care should be taken to ensure that the ductwork does not extend outside and beyond height limits as noted on the drawings.

b. All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be tight and shall be made in the direction of airflow.

c. The ducts shall be reinforced where necessary, and must be secured in place so as to avoid vibration of the duct on its support.

d. All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration. All ducts shall be fabricated and installed in accordance with modern design practice. The sheet metal gauges and fabrication procedures as given in I.S. specifications shall be adhered to and shall be considered as an integral part of these specifications.

e. The ductwork shall be varied in shape and position to fit actual conditions at building. All changes shall be in accordance with accepted duct design and subject to the approval of the engineer-in-charge.

f. Sponge rubber or approved equal gaskets shall be installed between all connections of sheet metal ducts to walls. Sheet metal connections shall be made to walls and floors by means of galvanized steel angles anchored to the building structure with anchor bolts and with the sheet bolted to the angles. Sheet metal connections shall be as shown in the drawings or as directed by Engineer-in-Charge.

g. All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze hangers formed of galvanized steel rods and galvanized steel angle/channel under ducts. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods and angles / channels shall be hung through these cleats. 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. Hanger rods shall then hang through the cleats.

h. Where ducts pass through brick or masonry openings, it shall be provided with 25 mm thick TF quality thermo Cole around the duct prior to sealing of the opening.

i. All ducts shall be totally free from vibration under all conditions of operation. Whenever ductwork is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a flexible connection, located at the unit discharge. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve at least 100 mm long but not more than 200 mm, securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting ductwork rigidly held by independent supports on both sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation.

j. Flanges and supports are to be black, mild steel and are to be primer coated on all surfaces before erection and painted with aluminum thereafter. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.

k. The ductwork should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling Contractors.

4. DAMPERS
At the junction of each branch duct with main duct and split of main duct, volume control dampers must be provided. Dampers shall be rigid in construction to the passage of air.

The volume dampers shall be of an approved type, lever operated and complete with suitable level links & quadrants, locking devices, which will permit the dampers to be adjusted and locked in any position.

The dampers shall be of opposed blade or louver type. The damper blade shall not be less than 1.25 mm (18) gauge and shall not be over 225 mm wide. Automatic and manual volume opposed blade dampers shall be complete with frames and bronze bearings as per drawings. Damper frames shall be constructed of 16 gauge steel.

After completion of the ductwork, dampers are to be adjusted and set to deliver the required amount of air as specified in the drawings.

5. **ACCESS PANEL**

A hinged and gasket access panel shall be provided on ductwork before each control device that may be located inside the ductwork. Doors shall be provided with neoprene rubber gaskets. Angle joints shall be provided with neoprene rubber gaskets for leak tightness of the joints. Access door/panels shall be provided:

- Near each smoke sensor
- Any other place specifically mentioned in the drawing or if asked by CLIENT/ HITES during execution stage.

6. **MISCELLANEOUS**

   a. Sponge rubber gaskets also to be provided behind the flange of all grills.
   b. Each shoot from the duct, leading to a grille, shall be provided with an air deflector to divert the air into the grille through the shoot.
   c. Inspection doors measuring at least 450 mm x 450 mm are to be provided in each system at an appropriate location, as directed by Engineer-in-Charge.
   d. Diverting vanes must be provided at the bends exceeding 600 mm and at branches connected into the main duct without a neck.
   e. Proper hangers and supports should be provided to hold the duct rigidly, to keep them straight and to avoid vibrations. Additional supports are to be provided where required for rigidity or as directed by Engineer-in-Charge.
   f. All duct supports, flanges, hangers and damper boxes etc. Shall be given 2 coats of red oxide paint before installation and one coat of aluminum paint after the erection, at no extra cost.
   g. All angle iron flanges are to be welded electrically and holes to be drilled.
   h. All the angle iron flanges are to be connected to the GSS ducts by rivets at 100 mm centers.

25. **GRILLS / DIFFUSERS**

1. **SUPPLY AND RETURN AIR DIFFUSERS**

Supply and return air diffusers shall be made of extruded aluminum section. The diffusers shall be powder coated in finish. Supply air diffusers shall be provided with screw operated opposed blade volume control devices of extruded aluminum in black anodized finish. The diffusers shall be suitable for concealed fixing arrangement and as approved by Engineer-in-charge/HITES. It should be anti-smudge type. Colour code of diffuser needs to be approved by E-I-C.

The diffusers shall be provided with removable central core.
All diffusers shall be selected as per selection curves and in consultation with Engineer-in-charge / HITES. All diffusers shall have soft continuous rubber/foam gasket between the periphery of the diffusers and the surface on which it has to be mounted.

a. **LINEAR GRILLS:**

Linear continuous supply or return air grills shall be extruded aluminum construction with fixed horizontal bars at 150 inclination with flanges on both sides. The thickness of fixed bar louvers shall be 5mm in front and the flange shall be 20mm wide with round edges. The grille shall be suitable for concealed fixing and horizontal bars of the grille shall be mechanically crimped from the back to hold them.

Volume control device of extruded aluminum construction in black anodized finish shall be provided in S.A. duct collars.

b. **DOUBLE ADJUSTABLE LOUVERED SUPPLY/ RETURN AIR GRILLS WITH HORIZONTAL /VERTICAL OR VERTICAL/ HORIZONTAL LOUVER ARRANGEMENT:**

The grille shall be adjustable as each louver shall be pivoted to provide pattern with 00 to plus or minus 150 ARC upto 300 deflection down towards. The louvers shall hold deflection settings under all conditions of velocity and pressure. The rear louver of the register shall be in black shade.

Volume control device of extruded aluminum construction with black anodized finish shall be provided in S.A. grills.

c. **EXHAUST AIR REGISTER:**

Exhaust air register shall be made of extruded aluminum with fixed horizontal louvers at 40 degree angle setting on a 20 mm louvers pitch. The register shall have 20 mm wide flange with round edges all around. The register shall be suitable for front screw fixing.

Volume control device of extruded aluminum construction with black anodized finish shall be provided.

d. **MULTI SLOT CEILING DIFFUSERS:**

Multi slot ceiling diffuser shall be made of extruded aluminum with various slot width and air pattern deflectors. Deflectors in each slot provide an adjustable air pattern of 180 degree full. A special plenum shall be provided for each supply air diffuser. The linear diffuser shall have alignment strips to give straight look while installation.

Hit & miss type volume control damper of extruded aluminum construction with mill finish shall be with multi-slot supply air diffuser.

e. **LINEAR CEILING MOUNTED DIFFUSERS:**

Linear ceiling mounted air terminals shall be made of extruded aluminum surface mounted one way or two way pattern. The linear terminal shall have alignment strips to give straight look while installation. Volume control device of extruded aluminum construction in mill finish shall be provided in S.A. diffuser. It should be anti smudge type. Colour code needs to be approved by E-I-C.

f. **FRESH AIR INTAKE LOUVERS:**

Fresh air intake louvers 50 mm deep (minimum) wherever required as per shop drawing will be made of extruded aluminum construction duly anodized or powder coated. Bird/insect screen will be provided with the intake louvers. The blades are inclined at 450 on a 40 mm blade pitch to minimize water ingress. The lowest blade of the assembly shall extend out slightly to facilitate disposal of rainwater without falling in door/wall on which it is mounted.

Wherever specified, the intake louvers shall be provided with factory fitted all aluminum construction volume control dampers in black anodized finish.
g. LAMINAR FLOW DIFFUSERS

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 diffusers are constructed from 18 swg Aluminium sheet, perforated face with approx 50% perforation. The perforated front face is openable hinge type complete with key operated dampers from front.

iii. SIZES

Available in standard sizes of 600 x 600 mm, 900 x 600 mm & 1200 x 600 mm or as per requirements.

iv. FEATURES

• Suitable for modular panel assemblies.
• Top entry with opposed blade dampers.
• Pivoting type face plate for damper operation from front.
• Easy maintenance and cleaning.

v. FINISHESD STANDARD

a) Epoxy Polyester Powder Coated off white/pure white
b) Natural anodised.
c) Diffuser shall be smudge proof type.

2. MOTORIZED COMBINED SMOKE & FIRE DAMPERS – SPRING RETURN

All supply and return air ducts at AHU room crossings (or ducts as applicable) and at all floor crossings shall be provided with approved make fire and smoke dampers of at least 90 minutes fire rating certified by CBRI ROORKEE as per UL 555:1973

Fire damper blades & outer frame shall be formed of 1.6 mm galvanized sheet steel. The damper blade shall be provided on both ends using chrome-plated spindles in self-lubricated bronze bushes. Stop seals will be provided on top and bottom of the damper housing made of 16 g galvanized sheet steel. For preventing smoke leakage side seals will be provided.

In normal position damper blade shall be held in open position with the help of a 24 V operated electric actuators thereby providing maximum air passage without creating any noise or chatter.

The damper shall be actuated through electric actuator. The actuator shall be energized with the help of a signal from smoke detector installed in AHU room/R.A. duct/damper. The A/C Contractor shall also provide smoke detector. The fire damper shall also close due to Temp. rise in S.A. ducts thru the electric temp. sensor factory set at 165 Deg. F micro switches with bake lite base will be provided to stop fan motor and give open & close signal at remote panel in case of motorized actuator.

Each dampers in case of motorized smoke-cum-fire damper shall have its own panel which will incorporate necessary circuit required to step down voltage available from power supply to shown status of the damper (open or close), to allow remote testing of damper & indication in event of damper closure due to signal from smoke sensor/ temp. sensor & reset button. Additional terminal will be provided to have signal (sound beep or visual) in central control room.
Damper actuator shall be spring return so as to close the damper in the event of power failure automatically and open the same in case of power being restored.

Spring return action of the actuator shall be an in-built mechanism and shall not be mounted externally.

The damper shall be installed in accordance with the installation method recommended by the manufacturer.

3. **PAINTING**

All grilles, and diffusers shall be powder coated in color as approved by Engineer-in-charge/HITES before installation.

All ducts immediately behind the grilles/diffusers etc. Are to be given two coats of black paint in Matt finish.

4. **TESTING**

After completion, all duct system shall be tested for air leakage.

The entire air distribution system shall be balanced to supply the air quantity as required in various areas and the final balance of air quantity through each outlet shall be submitted to the engineer-in-charge for approval. Measured air quantities at fan discharge and at various outlets shall be identical to or less than 5% in excess of those specified and quoted. Branch duct adjustments shall be permanently marked after air balancing is completed so that these can be restored to their correct position if disturbed at any time.

26. **SHEET METAL WORKS — (FACTORY FABRICATED)**

1. **GENERAL**

   i. The work under this part shall consist of furnishing labour materials, equipment and appliances as specified necessary and required to install all sheet metal and other allied work to make the air conditioning supply, ventilating, and exhaust system ready for operation as per drawings.

   ii. Except as otherwise specified all duct work and related items shall be in accordance with these specifications.

   iii. Ductwork shall mean all ducts, casings, dampers, access doors, joints, stiffeners and hangers.

2. **DUCT MATERIALS**

   i. The ducts shall be fabricated from galvanized steel sheets sheets (with light coating of zinc which shall be lead free) class VIII conforming to ISS:277-1962 (revised) or aluminium sheets conforming to ISS:737-1955 (wherever aluminium ducts are specified).

   ii. All duct work, sheet metal thickness and fabrication unless otherwise directed, shall strictly meet requirements, as described in IS:655-1963 with amendment-I (1971 edition)

   iii. GOVERNING STANDARDS: Unless otherwise specified here, the construction, erection, testing and performance of the ducting system shall conform to the SMACNA-1995 standards (“HVAC Duct Construction Standards-Metal and Flexible-Second Edition-1995” SMACNA)

3. **RAW MATERIAL**

   i. Ducting

      a. All ducting shall be fabricated of LFQ (Lock Forming Quality) grade prime G.I. row material furnished with accompanying Mill test Certificates.
b. Galvanizing shall be of 120gms/sq.m. (total coating on both sides).

c. In addition, if deemed necessary, samples of raw material, selected at random by CLIENT/ HITES's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

d. The G.I. raw material should be used in coil-form (instead of sheets) so as to limit the longitudinal joints at the edges only irrespective of cross-section dimensions.

ii. **Duct Connectors and Accessories**

   All transverse duct connectors (flanges/cleats) and accessories/related hardware are such as support system shall be zinc-coated (galvanized)/

4. **FABRICATION STANDARDS**

   i. All ductwork including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and other transformation pieces to provide the requisite quality of ducts and speed of supply.

   ii. Coil lines to ensure location of longitudinal seams at comes/folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any face side of the duct.

   iii. 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.

   iv. All edges to be machine treated using lock formers, flanges and roller for fuming up edges.

   v. Sealant dispensing equipment for applying built-in sealant in Pittsburgh lock where sealing of longitudinal joints are specified.

5. **SELECTION OF G.I. GAUGE AND TRANSVERSE CONNECTORS**

   Duct Construction shall be in compliance with 1‖ (250 Pa)w.g. static norms as per SMACNA.

   All transverse connectors shall be the Rolamate 4-bolt slip-on flange system or Techno Fabriduct imported makes of similar 4-bolt systems with built-in sealant if any to avoid any leakage additional sealant to be used.

   The specific class of transverse connector and duct gauge for a given duct dimensions will be 1‖(250 Pa) pressure class.

   Non-toxic, AC-applications grade P.E. or PVC Casketing is required between all mating flanged joints. Gasket sizes should conform to flange manufacturer’s specification.

6. **DUCT CONSTRUCTION**

   The fabricated duct dimensions should be as per approved drawings and all connecting sections are dimensionally matched to avoid any gaps.

7. **DIMENSIONAL TOLERANCES:**

   a. All fabricated dimensions will be within +/- 1.0 mm of specified dimension. To obtain required perpendicularity, permissible diagonal tolerances shall be +/- 1.0 mm per meter.

   b. Each and every duct pieces should be identified by color coded sticker which shows specific part numbers, job name, drawing number, duct sizes and gauge.

   c. Ducts shall be straight and smooth on the inside Longitudinal seams shall be airtight and at comers only, which shall be either Pittsburgh or Snap Button Punch as per SMACNA practice, to ensure air tightness.
d. Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Turning vanes or air splitters shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.

e. Plenums shall be shop/factory fabricated panel type and assembled at site.

f. **Factory Fabricated ducts shall have the thickness of the sheet shall be as follows.**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Size of Duct</th>
<th>Sheet Thickness</th>
<th>Fastener Size</th>
<th>Type of Joints</th>
<th>Bracing with GI tie rods of following sizes</th>
<th>Support Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Upto 750 mm</td>
<td>0.63 mm</td>
<td>3/8&quot;</td>
<td>Fabricated out of G.i. sheet of 24 gauge at every 1.2 m internal.</td>
<td>Cross tie rods to be fitted of suitable dia GI rod for each piece of duct</td>
<td>25x25x3 mm</td>
</tr>
<tr>
<td>2</td>
<td>751 mm to 1000 mm</td>
<td>0.80 mm</td>
<td>3/8&quot;</td>
<td>E-24 type flange, shall be fabricated out of 24 G sheet at every 1.2 m internal.</td>
<td></td>
<td>25x25x3 mm</td>
</tr>
<tr>
<td>3</td>
<td>1001 mm to 1500 mm</td>
<td>0.80 mm</td>
<td>5/8&quot;</td>
<td>E-22 type flange shall be fabricated out of 22 G sheet at every 1.2 m internal.</td>
<td>Cross tie rods to be fitted of suitable dia GI rod for each piece of duct</td>
<td>40x40x5 mm</td>
</tr>
<tr>
<td>4</td>
<td>1501 mm to 2250 mm</td>
<td>1.00 mm</td>
<td>5/8&quot;</td>
<td>J-16 type flange, shall be fabricated out of 16G sheet at every 1.2 m internal.</td>
<td>Cross tie rods to be fitted of suitable dia GI rod for each piece of duct</td>
<td>40x40x6 mm angle</td>
</tr>
<tr>
<td>5</td>
<td>2251 mm and above</td>
<td>1.25 mm</td>
<td>5/8&quot;</td>
<td>J-16 type flange, shall be fabricated out of 16G sheet at every 1.2 m internal.</td>
<td>50x50x6 mm with MS rods of 12 mm dia.</td>
<td></td>
</tr>
</tbody>
</table>

g. The gauges, joints and bracings for sheet metal duct work shall further conform to the provisions as shown on the drawings.

h. Ducts larger than 600 MM shall be cross broken, duct sections upto 1200 MM length may be used with bracing angles omitted.
i. 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.

j. All ducts shall be supported from the ceiling/slab by means of M.S. Rods of 10 MM (3/8") DIA with M.S. Angle at the bottom. The rods shall be anchored to R.C. Slab using metallic expansion fasteners.

8. INSTALLATIONS

i. During the construction, the contractor shall temporarily close duct openings with sheet metal covers to prevent debris entering ducts and to maintain opening straight and square, as per direction of Engineer-In-Charge.

ii. Great care shall be taken to ensure that the duct work does not extend outside and beyond height limits as noted on the drawings.

iii. All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be air tight and shall be made in the direction of air flow.

iv. The ducts shall be reinforced with structured members where necessary, and must be secured in place so as to avoid vibration of the duct on its support.

v. All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration.

The duct work shall be varied in shape and position to fit actual conditions at building site. All changes shall be subjected to the approval of the Engineer-In-Charge.

vi. Sponge rubber or approved equal gaskets of 6 MM maximum thickness shall be installed between duct flanges as well as between all connections of sheet metal ducts to walls, floor columns, heater casings and filter casings. Sheet metal connections shall be made to walls and floors by means of wooden member anchored to the building structure with anchor bolts and with the sheet screwed to them.

vii. Flanges bracings and supports are to be Rolamate or Techno Fabriduct. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.

viii. Joints, seams, sleeves, splitters, branches, takeoffs and supports are to be as per duct details as specified, or as decided by Engineer-In-Charge.

ix. Joints requiring bolting or riveting may be fixed by Hexagon nuts and bolts, stove bolts or buck bolts, rivets or closed centre top rivets or spot welding. Self tapping screws must not be used. All jointing material must have a finish such as cadmium plating or Galvanized as appropriate.

x. Fire retarding flexible joints are to be fitted to the suction and delivery of all fans. The material is to be normally double heavy canvass or as directed by Engineer-In-Charge. On all circular spigots the flexible materials are to be screwed or clip band with adjustable screws or toggle fitting. For rectangular ducts the material is to be flanged and bolted with a backing flat or bolted to mating flange with backing flat.

xi. The flexible joints are to be not less than 75 MM and not more than 250 MM between faces.

xii. The duct work should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling contractors.
xiii. Duct passing through brick or masonry, wooden frame work shall be provided within the opening. Crossing duct shall have heavy flanges, collars on each side of wooden frame to make the duct leak proof.

9. DOCUMENTATION FOR CHECKS

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.

Check 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 Check sheet. The above system will ensure speedy and proper site verification and approvals.

10. 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 -100°C to 150°C

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 DBR 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.
C. PIPING / DUCT /EQUIPMENT INSULATION:

All pipe/duct insulation shall be as specified in DBR meeting functional requirements. Insulation will be XLPE/EPS/Nitrile Rubber/Glass Wool as per requirements & as specified in DBR.

D. MATERIAL

- Insulation material shall be Closed Cell Elastomeric Nitrile Rubber.
- Density of Material shall be between 50+/-10% Kg/m³
- Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/mK at an average temperature of 0°C.
- 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.
- Water vapour permeability shall not exceed 0.017 Perm inch (2.48 x 10^-14 Kg/m.s.Pa), i.e. Moisture Diffusion Resistance Factor or ‘µ’ value should be minimum 7000.
- Complete pipe insulation shall have 200 g/m² factory laminated, treated woven Glass Cloth coating for mechanical and UV protection.
- Thickness of the insulation shall be as specified for the individual application.
- An air gap of 25 mm shall be present between adjacent insulation surfaces carrying chilled water or refrigerant. Before applying insulation, all pipes shall be brushed and cleaned. All Pipe surfaces shall be free from dirt, dust, mortar, grease, oil, etc. Nitrile Rubber insulation shall be applied as follows:
  - Insulating material in tube form shall be sleeved on the pipes.
  - On existing piping, pre slit, self adhesive tube with factory laminated woven glass cloth coating shall be placed. Remove the release paper and make a seam joint. Cover the joint with integral glass cloth flap. Butt joints shall be sealed with adhesive and shall be covered with same glass cloth (slit opened tube of the insulating material (slit with a very sharp knife in a straight line) shall be placed over the pipe and) adhesive shall be applied as suggested by the manufacturer.
  - Adhesive must be allowed to tack dry and then press surface firmly together starting from butt ends and working towards centre.
  - Wherever flat sheets shall be used, Factory cut sheets shall be used (it shall be cut out in correct dimension.) All longitudinal and transverse joints shall be sealed as per manufacturer recommendations.
  - The insulation shall be continuous over the entire run of piping, fittings and valves.
  - All valves, fittings, joints, strainers, etc. in chilled water piping shall be insulated to the same thickness as specified for the main run of piping and application shall be same as above. Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced.
  - The detailed application specifications are as mentioned separately. The manufacturer’s trained installer should only be used for installation.

E. RECOMMENDED ADHESIVE

In all cases, the manufacturer’s recommended Adhesive (SR-998) should be used for the specified purpose.
F. **PUMP INSULATION**

Chilled water pump shall be insulated to the same thickness as the pipe to which they are connected and application shall be same as above. Care shall be taken to apply insulation in a manner as to allow the dismantling of pumps without damaging the insulation.

G. **SHELL INSULATION**

The chiller shells shall be factory insulated in accordance with the manufacturer’s standards.

H. **COLD WATER & EXPANSION TANK INSULATION**

Cold water tank, and chilled water expansion tank shall be insulated as per manufacturer’s standard.

I. **PARAMETERS FOR SELECTION OF THICKNESS**

a) Design Basis: Condensation Control  
b) Region: Costal Area  
c) Application: Outdoor & Indoor  
d) Design Conditions: 30 Deg. C & 82 % RH  
   
i) **Thickness of Insulation**  
e) Chilled Water Pipe Line Temperature 7.0 Deg. C

**Indoor Application (Conditioned / Semi Conditioned Space)**

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Insulation Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up To 50 mm</td>
<td>25 mm</td>
</tr>
<tr>
<td>Above 50 mm &amp; Up To 150 mm</td>
<td>32 mm</td>
</tr>
<tr>
<td>Above 150 mm Pipe Size</td>
<td>38 mm</td>
</tr>
<tr>
<td>Chilled Water Tank</td>
<td>32 mm</td>
</tr>
</tbody>
</table>

**Outdoor Application / Non Conditioned Space**

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Insulation Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up To 50 mm</td>
<td>32 mm</td>
</tr>
<tr>
<td>Above 50 mm &amp; Up To 150 mm</td>
<td>38 mm</td>
</tr>
<tr>
<td>Above 150 mm &amp; Up To 600 mm</td>
<td>44 mm</td>
</tr>
<tr>
<td>Chilled Water Tank</td>
<td>44 mm</td>
</tr>
</tbody>
</table>

ii) **Drain Water Pipe Line Temperature 15.0 Deg. C**

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Insulation Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up To 50 mm</td>
<td>19 mm</td>
</tr>
</tbody>
</table>

iii) **Refrigerant Pipe Line Temperature 3.0 Deg. C**

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Insulation Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up To 50 mm</td>
<td>25 mm</td>
</tr>
<tr>
<td>Above 50 mm &amp; Up To 100 mm</td>
<td>32 mm</td>
</tr>
</tbody>
</table>

J. **PRE-INSULATED DUCT WORK** - PRE-INSULATED ALUMINIUM POLYISOCYANURATE / POLYURETHANE FOAM DUCTWORK
The following preferred ductwork system to be installed:

Pre-insulated aluminium ductwork made of Poly isocyanurate sandwich panels, comprising an expanded Poly isocyanurate rigid foam board faced on both sides by aluminium foil.

Physical characteristics of the panels shall be as follows:

<table>
<thead>
<tr>
<th>Thickness of Panels</th>
<th>Air Conditioned Areas</th>
<th>Plant Rooms</th>
<th>Exposed To Weather</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20mm</td>
<td>30mm</td>
<td></td>
</tr>
<tr>
<td>Thickness of aluminium</td>
<td>80/80 Microns</td>
<td>80/200 Microns</td>
<td>80/200 Microns</td>
</tr>
<tr>
<td>Density of the foam</td>
<td>45 Kg/m3</td>
<td>48 Kg/m3</td>
<td>48 Kg/m3</td>
</tr>
<tr>
<td>Finishing of aluminium</td>
<td>Embossed</td>
<td>Embossed</td>
<td>Embossed</td>
</tr>
</tbody>
</table>

Both sides of the aluminium foils shall be lacquered with a 3g/m2 weatherproof and ultraviolet rays protection polyester lacquer.

All the panels shall have to be embossed with the name of the manufacturer and production date.

Thermal insulation characteristics shall be as follows:

- Insulating material: Close cell rigid expanded polyurethane foam, CFC free, density 45 to 48 Kg/m3, material physiologically and chemically inert and insoluble, vermin proof, fungus proof, non metabolisable.
- Thermal conductivity: 0.022 W/mK or better.
- Water absorption shall be less than 0.5% by 24 hours immersion test.
- Water vapour diffusion: \( M = \infty \) resistance.
- The aluminium foil covering the panel to be maintained intact after installation to ensure vapour barrier continuity.
- Proposed material should have minimum 5 years installation reference in the region.
- The panel manufacturer should be of European/Foreign origin.
- All the panels to be used should be labelled by authorised international fire laboratories.
- The panel manufacturer shall comply with Fire Mideast Product Listing (MPL) and Factory Production Control Certificate (FPC), by authorised international laboratories.
- The panel shall be tested and comply with the following standards:
  b. ASTM E84 Class “1”
  c. NFPA 255
  d. UL 723
  e. Toxicity Index shall not exceed 5.7 according to NES 713
  f. Class ‘O’ according to BS 476 Part 6 & 7

**Temperature Range:**

No relevant reduction of insulation, chemical or physical characteristics of the panels to be measurable, when conveying air in the temperature range of \(-35^\circ\text{C} \text{ to } +110^\circ\text{C}\).

Installation shall be supervised & certified by the manufacturer’s representative.
5-years warranty shall be offered for the insulation material characteristics.

**Joint System:**

The joints between the ducts shall be using tiger connectors or male - female connection system for small sizes up to 500mm and for bigger sizes more than 500mm aluminium /polymer invisible flanges and slide-in-channel to be used and to be connected by special cover corners, having a holding pin, which goes inside the flange and the insulation, to avoid any field connection and to give the system more strength.

Ductwork shall be installed, using supports, as described in DW144 & according to manufacturer’s requirements. Maximum distance between supports shall not exceed:

- 4000mm for ducts with section not exceeding 1200 x 1000mm
- 2000mm for ducts with section exceeding 1200 x 1000mm.

**EPS Insulation:** Expanded polystyrene (TF) quality shall be used as specified in DBR & meeting functional requirements. Minimum density shall be 20 kg/cum & maxm. Thermal conductivity shall be 0.035 K cal/hr degree C / m at 10 Degree C mean temperature. It shall be in compliance with latest ECBC & GRIHA norms. For pipe size below 150 mm dia., insulation thickness will be 50 mm & above 150 mm dia. pipe, it will be 75mm.

**Application of Insulation on Pipe (including suction pipe insulation):**

(i) The surface to be insulated shall be first cleaned & a coat of zinc chromate primer shall be given. The insulation shall be fixed tightly to the surface cold setting adhesive, CPRX compound. All joints shall be staggered & sealed. The second layer of insulation wherever required shall be similarly applied over first layer.

(ii) Pipes shall be preferably pre insulated at factory, meeting the requirement or the insulation shall be finished at site as under:

(a) For pipe laid outside the building, above ground, the finishing over the pipe insulation shall be finished with 0.63 mm GS sheet cladding over vapour barrier of 120 gm/sqm polythene sheet with 50 mm overlap & tied down with lacing wire & complete with type 3 grade I roofing feltstrip applied by means of cold setting CPRX compound.

(b) For pipes outside the building and underground, the insulation shall be covered with 500 gauge polythene faced hessian (polythene facing outwards), with 50 mm overlap. All joints shall be sealed with bitumen. A layer of 0.50 mm x 20 mm G.I wiremesh netting shall be provided over it butting all joints & it shall be laced down with G.I wire, sand cement plaster (1:4) 20 mm thick shall be provided in 2 layers of each 10 mm & shall be waterproofed by applying hot bitumen & fixing tarfelt over the plaster. It shall be finally finished with a coat of hot bitumen. In case of factory preinsulated pipe, buried underground, a water leakage sensing wire shall also be provided to detect the location of water leakage at later date.

(c) In case of factory pre insulated pipe, all joints shall be properly insulated at site as per recommendation of manufacture.

(iii) All valves, fittings, stairers etc. shall be insulated to the same thickness and in the same manner as for the respective piping, taking care to allow operation of valves without damaging the insulation.

### 27. 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/m°K 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 properties as per IS: 8225 / ISO 354 / ASTM423C. The insulation should be installed as per manufacturer’s recommendation.

2. Checks for Insulation

Unless otherwise specified checks for duct and pipe insulation for the project shall be on the basis of center line measurements described herewith

a. 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.

b. 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.

3. Duct Insulation Material

Thermal insulation material for Duct insulation shall be with factory laminated block 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/m°K or 0.212 BTU / (Hr-ft2-oF/inch) at an average temperature of 30°C. 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/ms.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.

**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>SA duct in RA path</td>
<td>13 mm</td>
</tr>
<tr>
<td>Ducted return air system</td>
<td>SA duct: 19 mm, RA duct: 13 mm</td>
</tr>
<tr>
<td>Both SA &amp; RA exposed</td>
<td>Both 25 mm</td>
</tr>
</tbody>
</table>

4. **DUCT INSULATION**

External thermal insulation shall be provided as follows:

The thickness of insulation material shall be as per DBR/drawings. Following procedure shall be adhered to:

- Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work.
- 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.

**QUALITY CHECKS ON DUCTING**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>DESCRIPTION</th>
<th>YES - OK</th>
<th>REMARKS</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>
</tr>
<tr>
<td>2</td>
<td>Valid for construction Drawings at site.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Cross breaking, bracings / reinforcements are as per standard.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Air tightness of transverse / Longitudinal Joints ensured.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Grease and heat resistant sealant for kitchen exhaust duct.</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>
</tr>
<tr>
<td>7</td>
<td>Check following aspects of duct supporting system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sl. No.</td>
<td>DESCRIPTION</td>
<td>YES - OK NO - X</td>
<td>REMARKS</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>---------</td>
</tr>
<tr>
<td>7.1</td>
<td>Hanger spacing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.2</td>
<td>Anchor bolts size and quality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.3</td>
<td>Primer painting of supports</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.4</td>
<td>Check allowable load on trapeze angle for bigger ducts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Check whether contractor has provided</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1</td>
<td>Vanes in elbows</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.2</td>
<td>Clinched collar at take Offs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.3</td>
<td>Splitters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Check transitions &amp; offsets slopes &amp; fabrication.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Whether the installed ducting is as per layout approved, check locations, headroom etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Whether grilles / diffusers are as per approved shade.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Check the method of installation for Grilles / Diffusers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Repair / paint damaged surfaces.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Check the coordination of following activities as per the given sequence:-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.1</td>
<td>Main Ducts Cut for taking collars</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.2</td>
<td>Match / Fabricate collar taking false ceiling framework for diffuser into account</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.3</td>
<td>Fix grilles / diffuser framework in false ceiling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.4</td>
<td>Install the collar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.5</td>
<td>Install diffuser</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>All elbows / turning points and branches to be properly supported</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Access door is provided at serviceable position for fan and fire damper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Air balancing for room is studied</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Air replacement is considered for air exhausted from room.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>PVC or stainless steel material is used for corrosive fume exhaust system.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Anti vermin netting installed for louvers removable and serviceable.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Water or gas vent outlet is not installed near air intake louver.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Kitchen exhaust is not short circuited to outdoor air intake louver.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sl. No.</td>
<td>DESCRIPTION</td>
<td>YES - OK NO - X</td>
<td>REMARKS</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>---------</td>
</tr>
<tr>
<td>23</td>
<td>Kitchen room pressure is slightly below the surrounding area.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Sound level of fan is studied.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Face velocity for louvers / grills / diffusers is studied.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Air distribution of the room is studied.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Cross break all flat surfaces to prevent vibrations or buckling due to air flow.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Sides of ducts having collar for grills should not be cross broken to facilitate alignment of grills.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>All bends and collars should have vanes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>If duct passes through fire chamber increase sheet thickness.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Kitchen exhaust ducts to be tapered at bottom for oil / grease collection.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Avoid flanged joints in kitchen exhaust duct above false ceiling.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>When aluminum ducts are used with steel angles, steel to be painted with Zinc chromate paint</td>
<td></td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>Provide check nuts with duct hangers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Ducts below 250 mm should not be more than 1 m long to facilitate proper joining.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Plenums should have flanged and bolted ends for rigidity and easy maintenance.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>Avoid 'U' bends in ducts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>Provide long radius bends and offsets.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>No collars to be taken from top.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Install duct spool pieces near equipment for easy removal.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

28. PIPING AND FITTINGS

1. SCOPE
   The scope of this section comprises the supply and laying of pipes required for chilled water; condenser water & drain water conforming to these specifications and in accordance with the functional requirement and DBR.

2. WATER PIPING
   i. MATERIAL
   Water piping fittings and valves shall be of the following makes or approved equal make and shall conform to IS standards as indicated below.
a. Pipes

- UPTO 150 mm :- MS, Class C (Heavy Class) as per IS 1239 (Part I & II) 1990/1992
- 200 mm & ABOVE: Welded Black Steel Pipe Class 2 (6.35 mm Thickness) As per IS 3589 (LATEST)

All welding shall be done by qualified welders and shall strictly conform to Standard Code of practice for manual metal arc, welding of Mild Steel.

First butt weld of each welder shall be fully radiographed by HVAC contractor under guidance of HITES for testing purposes. Upon approval of welding joints the concerned welder shall be allowed to carry further welding of pipes. Rest of the welds shall have 100% visual inspection.

All welded joints (except pipe welded end-to-end) shall be made by use of forged one-piece welding flanges, caps, nozzles, elbows, branch outlets and tees of approved make. Cut samples shall be submitted for approval, if directed. All such fittings etc., shall be of a type which maintain full wall-thickness at all points, simple radius and fillets, and proper bevels or shoulders at ends.

All jobs welding shall be done by the electric arc welding process in accordance with the following:

- All joints shall have 45-degree bevel type, pipe mill-beveled or machine-beveled by the contractor.
- All scale and oxides shall be removed with hammer, chisel or file and bevel left smooth and clean.
- Pipe lengths shall line up straight with abutting pipe ends concentric.
- Both conductors from the welding machine shall be extended to locations at which welding work is being done. The leads from welding machine to location of welding work shall be held together with tape or other approved means as to prevent induced current in structural steel, in piping or in other metals within the building. The ground lead shall be connected to length of pipe through joints in pipe, structural steel of building or steel pipe supports.

b. GATE & GLOBE VALVES

Make: As approved shall be heavy duty non rising spindles as per IS 780, 778 and flanges as per IS 1536 and factory tested for 10 Kg/ sq cm test pressure

<table>
<thead>
<tr>
<th>S.No</th>
<th>Size</th>
<th>Construction</th>
<th>Ends</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>15 TO 40 MM</td>
<td>Gun metal body</td>
<td>Screwed</td>
</tr>
<tr>
<td>B</td>
<td>50 MM and above</td>
<td>Cast Iron Body &amp; spindle valve, seat wedge etc.,</td>
<td>Flanged</td>
</tr>
<tr>
<td></td>
<td>of Brass or Gun Metal</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

c. BALANCING VALVES

The balancing valves control and shut off valves with built in pressure drop and flow measuring facility shall be provided in the water outlet pipes of condensers and chillers, AHUs or wherever shown in tender drawings.

i. 15-50 mm Size: Gunmetal ASTM B-6 2 Screwed ends conforming to BS 5154

ii. 65mm and above: Cast iron, flanged ends with stainless steel trim.

The valves shall have PTFE/SS disc with special erosion/corrosion proof sealing. The valves shall have temper proof adjustable and lockage arrangement for required water quantity after commissioning. The valves shall be complete with pressure test cock and drain cocks.
To enable accurate and practical operation, measurement of flow and differential pressure shall be made with a computerized balancing instrument which shall enable the operator to read the flow directly without the use of diagrams or tables. In addition to measuring flow rate, differential pressure and temperature, computerized balancing instrument shall have a computer programs to provide the following functions:

To balance the HVAC installation and calculate the necessary valve settings, based on system measurements.

To store the results of balancing.

To log measured values from a valve (differential pressure, flow rate or temperature)

To printout saved data in computerized measurement protocol (CMP) consisting of:

- Name and size of Balancing Valve (BV)
- Presetting position of BV
- AP at BV
- Flow at BV
- Design Flow

Flanges shall be of approved make. The supply of flanges shall form part of piping (not separately identified in DBR ) and shall also include supply of bolts, washers, nuts and suitable rubber insertion gaskets (minimum 3 mm thick).

d. BUTTERFLY VALVES

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.

e. BALL VALVES

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/sqcm, 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.

f. SLUICE VALVES

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.

g. NON RETURN VALVES

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/sqcm, maximum operating temperature- 80 degree C. In case of any discrepancies between manufacturer’s
h. STRAINERS

Strainers shall be 'Y' type or Pot type Strainers as shown on drawings and as per requirements. 'Y' Strainer shall be fabricated out of MS 'C' class pipe two sizes higher than that of Strainer pipe size. Flanges as per B.S. 10 shall be provided at inlet and outlet connectors. The body shall be pressure tested at 10 kg/cm² and shall be hot dip galvanized. Permanent magnet shall be provided in the body of the Strainer to arrest MS particles. Filter element shall be of non-magnetic 20 gauge SS sheet with 3 mm perforation. Strainers shall be provided at inlet of each Air Handling Unit and Pump as shown in drawings and as per requirements.

Pot Strainers body shall be fabricated out of MS plate IS 226. Thickness of sheet shall be as per size of the strainer chamfered pipes with flanges shall be provided at inlet / outlet connections of the strainer. The tangential entry of water shall create a centrifugal action and due to velocity shall separate sediments and deposit on the inner surface of Filter Element and at bottom of the Strainer. Butterfly valves shall be provided at inlet/outlet connections as shown in drawing and as per requirements. The strainer body shall have two separate chambers properly sealed to avoid mixing of filtered and unfiltered water. A powerful magnet shall be provided in the body to arrest MS particles. Filter element of Pot Strainer shall be of non-magnetic 18 gauge SS sheet properly reinforced to avoid damage of the element. A cone with sufficiently to flush out foreign particles. This arrangement shall avoid frequent opening of Pot Strainer for cleaning of filter element. Gage connection shall be provided at inlet and outlet connection. A set of MS flanges with tongue and groove arrangement and neoprene rubber gasket shall be provided on the top cover and Pot Strainer flange with sufficient bolts and nuts to make the joint watertight. Bearing loaded top cover lifting and swinging arrangement shall be provided. The Pot strainer body shall be properly de-rusted and epoxy coated from inside and outside. Manufacturers Test Certificate shall be provided with each Pot Strainer.

Size of various Pot Strainer, Filter Element and Thickness of MS sheet shall be as detailed below:

<table>
<thead>
<tr>
<th>Size (mm)</th>
<th>Pot Dia. (mm)</th>
<th>Pot HT (mm)</th>
<th>Element Dia. (mm)</th>
<th>Element HT (mm)</th>
<th>MS Plate Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>300</td>
<td>400</td>
<td>200</td>
<td>240</td>
<td>6</td>
</tr>
<tr>
<td>80</td>
<td>350</td>
<td>450</td>
<td>250</td>
<td>250</td>
<td>6</td>
</tr>
<tr>
<td>100</td>
<td>450</td>
<td>500</td>
<td>300</td>
<td>280</td>
<td>6</td>
</tr>
<tr>
<td>125</td>
<td>500</td>
<td>600</td>
<td>330</td>
<td>340</td>
<td>8</td>
</tr>
<tr>
<td>150</td>
<td>540</td>
<td>700</td>
<td>360</td>
<td>390</td>
<td>8</td>
</tr>
<tr>
<td>200</td>
<td>610</td>
<td>815</td>
<td>400</td>
<td>470</td>
<td>8</td>
</tr>
<tr>
<td>250</td>
<td>800</td>
<td>955</td>
<td>550</td>
<td>510</td>
<td>8</td>
</tr>
<tr>
<td>300</td>
<td>1000</td>
<td>1105</td>
<td>750</td>
<td>580</td>
<td>8</td>
</tr>
<tr>
<td>350</td>
<td>1190</td>
<td>1300</td>
<td>895</td>
<td>678</td>
<td>12</td>
</tr>
<tr>
<td>400</td>
<td>1350</td>
<td>1500</td>
<td>1020</td>
<td>785</td>
<td>12</td>
</tr>
<tr>
<td>450</td>
<td>1518</td>
<td>1700</td>
<td>1060</td>
<td>890</td>
<td>12</td>
</tr>
<tr>
<td>500</td>
<td>1690</td>
<td>1800</td>
<td>1100</td>
<td>900</td>
<td>12</td>
</tr>
<tr>
<td>600</td>
<td>2000</td>
<td>2200</td>
<td>1500</td>
<td>1160</td>
<td>12</td>
</tr>
</tbody>
</table>

The Y-Strainer & Pot Strainer confirming to SSPL 107 & SSPL 106 shall have cast iron body and factory tested at works at 16 Kg/sq.cm pressure. The screen shall be made out of 3 mm perforated stainless steel sheet. It should be easily removable when required to be cleaned. Isolating butterfly valves at either end of the pot strainer shall be provided.
Each pot strainer shall be provided with a Test Certificate.

All chilled water piping and fittings shall be pressure tested, painted and then insulated as described under the section "Insulation".

i. **AUTO AIR VENT VALVES**

Air vent valves shall be provided at all higher points in piping system for venting and of following sizes:

- Up to 100 mm dia pipes: 25 mm dia.

Air vent valves shall be Gun metal and tested up to pressure of Class I pressure rating.

j. **FITTINGS**

The dimensions of the fittings shall conform to IS 1239/69 Part II (as per latest amendment) unless otherwise specified in specification.

All bends in sizes up to and including 150 mm dia shall be readymade of heavy-duty, wrought steel of appropriate class.

All fittings such as branches, reducers etc in all sizes shall be fabricated from pipes of same dia and thickness and length at least twice the dia of pipe.

The branches may be welded straight to main line.

Blank ends are to be formed with flanged joints and 1 mm thick blank insertion of rubber gasket between flange pair for 150 mm and over in case where a future extension is to be made otherwise blank end discs of 6 mm thickness are to be welded on with additional cross stiffeners.

The tender drawings show schematically the size and location of pipes but this is for contractor’s guidance only. Pipe runs may be changed to meet the site conditions.

3. **PIPING INSTALLATION**

a. All piping work shall be carried out in workman-like manner causing minimum disturbance to the existing services.

b. Piping shall be of steel, primer coated with rust preventive paint and finished with approved shade. Pipe supports shall not exceed the following spacing:

<table>
<thead>
<tr>
<th>Pipe Size (MM)</th>
<th>Spacing (Mtr)</th>
<th>Rod Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>2</td>
<td>10 mm</td>
</tr>
<tr>
<td>30 to 75</td>
<td>2.5</td>
<td>10 mm</td>
</tr>
<tr>
<td>100 and above</td>
<td>3.0</td>
<td>12.5 mm</td>
</tr>
</tbody>
</table>

Pipe hangers shall be fixed on walls and ceiling by means of metallic Raw bolts or approved shear fasteners.

c. Piping shall be properly supported on, or suspended from, stands, clamps, and hangers as specified and as required. The contractor shall adequately design all the brackets, saddle, anchors, clamps and hangers and be responsible for their structural sufficiency.

d. Vertical risers shall be parallel to walls and columns. Risers passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe and with a 10 mm thick rubber pad or any resilient material. Where pipes pass through the terrace floor, suitable flashing shall be
provided to prevent water leakage. Risers shall also have a duck foot elbow or steel support welded to the pipe at the lowest point. On risers drain valves shall be provided at heels.

e. Pipe sleeve of 50 mm larger than the pipe diameter shall be provided wherever pipes pass through walls and the annular space filled with felt and finished with retaining rings. In case of an insulated pipe the diameter shall be inclusive of insulation.

f. Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. Metal sheet shall be provided between the insulation and clamp, saddle or roller extending at least 150 mm on both sides of clamp, saddle or roller.

i. PRESSURE GAUGES AND THERMOMETERS

a. 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 Celsius to 60 degree Celsius. 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/sqcm.

b. Thermometer shall be stem type and shall be provided at inlet and outlet of each cooling coil.

4. TESTING

a. All water piping shall be tested to hydrostatic test pressure of at least one and a half times the maximum operating pressure but not less than 10 kg/sq cm 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 HITES.

b. Pipes repaired subsequent to above pressure shall be retested in same manner.

c. Piping may be tested in section and such sections shall be securely capped.

d. The Contractor shall ensure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipments in the system concerned. If proper circulation is not achieved due to air bound connections, the ‘Contractor’ shall rectify the defective connections. He shall bear all the expenses for carrying out above rectifications involving tearing up and refinishing of floor walls etc as required.

e. The Contractor shall give sufficient notice to all other agencies at site, of his intention to test a section or sections of piping and all testing shall be witnessed and recorded by Engineer in-charge at site.

f. The contractor shall provide temporary pipe connections to initially by-pass condenser/chiller and circulate water through condenser / chilled water pipe lines for minimum 8 hours. Water should be drained out from the lowest point. The temporary lines shall be removed and blanked with dead flanges. Pot strainers and Y strainers shall be cleaned and fresh water filled in the circuits.

g. After the piping has been installed, tested and run for at least three days of eight hours each, all un-insulated exposed piping in plant room shall be given two finish coats, 3 mills each of approved colour, conforming to relevant BIS Codes. The direction of flow of fluid in the pipes shall be visibly marked with identifying arrows. For painting of insulated and clad pipes refer to insulation section.

h. After testing, all systems shall be chemically cleaned. After cleaning, the pipe work should be rinsed multiples times until the system is neutral. The contractor shall make a report conforming the above to Engineer in charge for records.
i. The Contractor shall provide all materials, tools, equipments, services and labour required to perform the test and to remove water resulting from cleaning and testing.

5. BALANCING
   a. After completion of the installation, all water systems shall be adjusted and balanced to deliver water quantities as specified.
   b. Instruments required for the water balancing (computerized balancing instrument) shall be accurately calibrated in an approved manner before taking any measurements. Calibrated orifices and portable flow meters shall be used to balance the water flow. Orifices used for testing and balancing shall be installed with straight length up stream and down stream as recommended by the manufactures and shall be left permanently installed in the system.
   c. Automatic control valve and three way valves shall be set for full flow conditions during balance by procedure. Water circuit shall be adjustable by balancing cocks provided for balancing. These shall be permanently marked after balancing is completed so that they can be restored to their correct positions of disturbed.

6. PAINTING
   In case of pipes to be insulated after thorough anti grease and rust removal treatment, clean the pipe and then apply two coats of epoxy primer before applying in insulation treatment as specified elsewhere. All uninsulated pipes after de rusting will be provided with two coats of epoxy primer followed by epoxy paint of approved shade.

7. FIRE BREAKS INSULATION
   Firebreaks shall be provided in all ducts for internal lining/external thermal insulation after a run of 10 m center to center. There shall be a discontinuity of the insulating material in the form of MS angle of a minimum of 50 mm x 50 mm x 3 mm size. At the interface of the MS angle and insulating material, proper care of tucking in of the insulating material shall be taken so as to prevent erosion.

29. VACUUM DEGASSER, AIR & DIRT SEPARATOR & DIRT SEPARATOR
1. VACUUM DEGASSER
   The vacuum degasser shall be of a solid and a robust construction. The Vacuum degasser shall work on the Principle of pressure differential deaeration. Vacuum degasser shall be installed in a by pass line to CHW header. It shall be able to degas a minimum of 1 CMH or 1000 l/h of water at system working pressure.

   The degasser shall be capable of refilling the CHW pipeline with degassed water to compensate the volume of vented gases, unit shall be selected as per system's highest working pressure with following features
   • Fully automated degassing and water make-up
   • The Deagasser shall be able to switch itself off when the pipeline achieves desired Pressure & degassed levels of water.

   • Works on pressure differential deaeration principle
     • Built in flow meter to measure degassed and make-up water volumes
     • Microprocessor based control panel
     • BMS compatible
• All Components, i.e. pump, vacuum tube, valves, interconnecting piping and control panel mounted on a compact steel frame, it should be with a Multi-stage Centrifugal pump

The Degasser shall be of Plug & play type & shall be of automatic operation. Vacuum degasser shall consist of

• Vacuum tube with high capacity automatic airvent with an ingress preventer.
• Multistage centrifugal pump.
• Make-up water and system inlet water connections with motorised valves.
• Water outlet connection with motorised valve to enable degasser operation even at low system pressure.
• (Manual preset flow control valves at inlet and outlet are not acceptable.)
• Pressure transmitter to regulate pressure / vacuum in the vacuum tube
• Built in flow meter to measure degassed and make-up water volumes.
• Microprocessor based, BMS compatible, control panel with IP54 protection.
• All Components, i.e. pump, vacuum tube, valves, interconnecting piping and control panel mounted on a compact steel frame.

2. DIRT SEPARATOR

The Dirt separator shall be of a solid and robust construction (Mild Steel). It shall be able to remove solid particles upto 5 microns from water at Velocity between 2-3m/s. All connections, fittings and heads shall be of carbon steel. The medium used to de-aerate and remove dirt shall be manufactured of Steel Tube & a mesh made of copper wire. This medium should be non clogging in nature. The flow should not be obstructed by the dirt collected. A Drain valve should be present at the bottom to remove the accumulated dirt without the need of shutting down the operation of the system. The Dirt Separator shall be insulated depending upon its location (outdoor or indoor). The pressure drop on account of the dirt separator shall not exceed 21 kPa at maximum flow of the chilled water system.

3. AIR & DIRT SEPARATOR

The Air and Dirt separator shall be of a solid and robust construction (Mild Steel). It shall be able to remove free air and microbubbles as well as remove solid particles upto 5 microns from water at Velocity between 2-3m/s. Removal of Air & dirt shall be through coalescence. The unit shall be able to condition the water to make it highly absorptive at all points in the system. This ensures that microbubbles can no longer exist at any point in the system. All connections, fittings and heads shall be of carbon steel. The medium used to de-aerate and remove dirt shall be manufactured of Steel Tube & a mesh made of copper wire. This medium should be non clogging in nature. An automatic air vent of at least 100mm free area to be connected at the top for the release of the air separated from the water. The flow should not be obstructed by the dirt collected. A Drain valve should be present at the bottom to remove the accumulated dirt without the need of shutting down the operation of the system. The Air & Dirt Separator shall be insulated depending upon its location (outdoor or indoor). The pressure drop on account of the air and dirt separator shall not exceed 21 kPa at maximum flow of the chilled water system.

4. CONDENSER WATER CONDITIONING EQUIPMENT

- Equipment to increase condenser circuit efficiency

Water conditioning equipment shall be non intrusive type which can be mounted on the periphery of the common condenser header and should help in Dissolves and removes existing lime-scale, Prevent new lime-scale accumulation, Enhances filtration efficiency, treats bacteria and algae & Inhibits corrosion.
The water conditioning equipment shall induce a decaying sine oscillation of ±150 kHz into the water system, essentially making the water in the pipe a part of an electric circuit. The process with charge Hard water which draws the bicarbonate negative (-) ions and calcium positive (+) ions together. The ions should form a microscopic cluster within micro-seconds. The cluster should be stable as long as the signal is present and shall be removed from the system at cooling tower level.

The signal should have the capability to travel at least 2,000 rmt pipeline.

The signal should be capable to travel in the pipe of any material of construction. PVC, MS, SS.

It should help to maintain the following parameters under control:

i. Condenser approach should be maintained less than 5Deg F and monitored which will help in direct savings in power at chiller.

ii. Stop use of anti-scalant, softener, chemicals etc. Biocide level should be reduced by 75% of the standard to take care of areas where the water has low or no flow

iii. This equipment shall remove legionella, e-coli, Klebsiella, pseudomonas.

The equipment should be with CE Marking & ISO Certification

**UVGI (Ultra Violet Germicidal Irradiation)**

Supply, Installation, testing, commissioning and handing over of the duct mounted/AHU mounted Ultra Violet Germicidal Irradiation System for maintaining indoor Air Quality in AHU unit. The lamp shall have 9000 hrs life, ballasts shall be electronic type, life rated greater than 15000 starts. An hour meter shall be provided in the remotely mounted electrical box to indicate Lamp change and should be designed to acheive kill rate of not less than 90% per pass. The prices to include all inter connected wiring between the UVGI Lamps. The system should be applied downstream of duct length and on the side of the AHU coil to ensure no mold growth.

Installation of UVGI frame in the duct shall be with factory provided Guide Rails and Installation Rails. Cover Plates and all necessary hardware required for installation shall be factory provided by "Manufacture " All wetted parts shall be Stainless Steel to render it suitable for use in Hospitals, Health Care Facilities, and in Food Processing Plants. All non wetted parts shall be powder coated.

The Lamps shall be 9000 hrs. life with not less than 25% derating provide Rated Average Life of 9000 hrs. Lamps shall be environmentally friendly.

Ballasts shall be electronic type, life rated for greater than 15,000 starts.

An Hour Meter shall be provided in the remotely mounted Electrical Box to indicate Lamp change. The Hour Meter shall have at least Two normally Open (NO) Dry Contacts, one to activate unit mounted indicating lamp to warn Lamp change, and the other for remote indication or interface to BMS.

It Should be designed to achieve Kill Rate not less than 90% per pass.

Appropriate Safety and Caution Notice shall be screen printed on the cover plate of UVGI frame and on the electrical box. Placing adhesive labels shall not be accepted, so as not to compromise on safety.

Proper supporting system of UVGI to be provided & will be in contractor’s scope.

**Air Ionizers:** (STP cum ETP Plant & STP Plant –Indoor Air quality):-

Air Ionizers of suitable CFM & adequate No. shall be provided as per relevant standards & norms by the EPC Contractor as per ACPH requirement of Plant Room of STP cum ETP and
STP (2 No. of Plant) to control the odor to acceptable level & maintain desirable indoor air quality inside the plant room. Ionizers will be placed after the fresh air fan & air will be supplied uniformly through perforated duct. It shall target the obnoxious/toxic/pungent smell gases & convert it into non-harmful gases. It should also target microorganisms & particle counts, VOC, static charges, mold growth, outside air contaminants etc.

The Air Purification System shall be a product of an established manufacturer. It shall be designed using ASHRAE Standard 62.1. The EPC contractor needs to provide Indoor Air Quality calculations using the formulas within ASHRAE Standard 62.1 to validate acceptable indoor air quality. The Air Purification Technology shall have been tested by UL or Intertek/ETL preferably to prove conformance to UL 867 for electronic devices. EPC Contractor shall submit their certifications along with their submittal.

Ionization system shall be capable of:

1. Effectively killing microorganisms downstream of the ionization equipment (mold, bacteria, virus, etc.).
2. Controlling gas phase contaminants generated from human occupants, building structure, furnishings and outside air contaminants.
3. Reducing space particle counts.
4. Reducing space static charges.
5. When mounted to the air entering side of a cooling coil, keep the cooling coil free from pathogen and mold growth.
6. EPC contractor shall provide documentation that proves the product has minimum kill rates for the following pathogens given the allotted time and in a space condition:
   a) MRSA: 99.5% in 60 minutes or less preferably
   b) E. Coli: 93.5% in 30 minutes or less preferably
   c) H1N1: 86.6% in 60 minutes or less preferably
   d) Aspergillus: 74.8% in 60 minutes or less preferably

30. PRESSURISED EXPANSION TANK WITH PRESSURIZATION UNIT

1. SCOPE OF WORK

This section deals with supply, erection, testing and commissioning of pressurized expansion tank for chilled water conforming to general specification and suitable for the duty selected as required.

PRESSURIZED EXPANSION TANK WITH PRESSURIZATION UNIT

2. CLOSED EXPANSION TANK

The closed expansion tank will be of M.S. construction with interchangeable EPDM-BUTYL rubber membrane. The expansion tank shall be complete with safety relief valve, pressure reducing valve and pressure gauge. The tank will be of pressure rating to suit the system pressure and will be sized to adequately compensate for water expansion due to operating temperature variations.

The tank shall be fabricated as per IS 2825-1969 for “non-fired pressure vessels” and the flanges shall be as per IS 6392-1971.

For chilled water application, it will be insulated with 50mm thick insulation to the specifications and cladded with 26G-aluminium cladding. The expansion tank shall be supplied along with pressurization unit.

3. PRESSURIZATION UNIT
Pressurization unit shall be with 2 nos. (1 working + 1 stand by) horizontal/vertical multi-stage pumps of suitable rating & capacity, as indicated hereunder, factory mounted on a steel frame along with interconnected piping, valves, strainer, pressure gauge, pressure transmitter, flow meter to measure the make-up water quantity, control panel with duty cycling and dry-run protection, electrical relays/contactors and interconnecting wiring:

Protection - IP55
Insulation class - F
Liquid temperature range - 0°C - 50°C

The unit shall be capable of Pressurising the system to the required pressure with suction from a break-tank located at least 1m above pump level. The control unit shall be housed in a metal box, IP 54 protection with BMS compatibility via an RS485 cable interface.

4. CENTRIFUGAL AIR SEPARATOR:
   It will be of M.S construction with preferably suitable for grooved connection. The Air separator will be of pressure rating to suit the system pressure & will be sized to achieve maximum air separation.
   The Air Separator will be complete with Automatic Air vent at the top & drain valve in the centre of the bottom. The Air separator will be insulated.

5. OPEN TYPE EXPANSION TANK
   Unless mentioned otherwise, an expansion tank of PVC double layered contain twice the maximum expansion likely to place in the system, shall be provided. The bottom of the tank shall be at least 600mm above the highest point of the system. Tank shall be insulated, if required and be complete with float valve, gauge glass, drain, overflow and make up connections, with gate valves and vent piping as required.

31. CO & CO2 SENSOR FOR BASEMENT CAR PARK VENTILATION
1. SCOPE OF WORK
   The scope of this section comprises the supply, installation, testing & commissioning of CO & Co2 Sensor for basement Car Park Ventilation in auto mode conforming to these specifications and in accordance with DBR and functional requirements.

2. TYPE
   Sensor should have single Unit for CO and CO2 monitoring with dedicated measuring sensor cell. It should be BMS compatible with analogue output of 4-20mA / 2-10 Volts. Sensor should not be cross-sensitive or respond to other ambient gases, including gases like SO2, acetone, ammonia, Nitrogen dioxide, Nitric oxide & should be wall mountable without need of further mounting brackets etc. It should have auto recovery to zero point with replaceable sensor cell. Sensor must have reverse polarity and short circuit protection along with over-flooding protection. Sensor should have IMMUNITY TO RF/FM INTERFERENCE as per the guidelines of EMC- Directive 2004/108/ EEC & should have enclosure flammability in accordance to UL 94: VO. The sensor should be UL, CE certified.
   Should have minimum IP65 protected housing, with provision of dust and moisture protection with hydrophobic filter arrangement.

3. SPECIFICATIONS FOR CARBON MONOXIDE DETECTION SENSOR
   It should be capable of continuous, online detection and measurement of carbon monoxide and carbon monoxide radicals & should have Electro-chemical type sensor cell. The same should have Gel based (not watery – for longer shelf life, no mounting orientation problem). Electrolyte sensor
cell. It should have 0-300ppm measuring range, taking care of over range detection. Response time should be < 15 sec & accuracy should be ≤ 1% of measuring range. It should have low warm up time ≤ 3 minutes. It should have plug-in, easy replaceable sensor cell (simple push – pull arrangement) and PCB for easy service and replacement (no need to change the whole unit). It should have manual trim-pot calibration facility, with annual calibration frequency.

4. SPECIFICATIONS FOR CARBON DIOXIDE DETECTION SENSOR

It should capable of continuous, online detection and measurement of carbon dioxide (CO2) concentration. It should have Gold plated non-dispersive infra-red (NDIR) sensor cell. It should have 0-2000ppm measuring range, taking care of over range detection. It should have low response time < 10 sec & should have low warm up time, ≤ 3 minutes.

5. SPECIFICATIONS FOR VERY EARLY FIRE & SMOKE DETECTION TRANSMITTER

It should capable of continuous, online detection and measurement of smoke & fire radicals. It should be unaffected by dust, moisture, vibration, temperature & other external factors. It should have low zero point drift along with modular plug in technology. It should be BMS compatible & should provide an analogue output of 4-20mA. There should be an option to provide Alarm Relay output. The Sensor should comply to EMC Directive 89/336/EEC & should be compliant to UL 94 V2.

32. TESTING, ADJUSTING AND BALANCING

The AC Contractor shall have a dedicated experienced, specialized, approved, testing and commissioning (T&C) team /agency responsible for coordination with other trades, preparation of T&C plan method statement & T&C procedures, organizing & scheduling the T&C activities along with the progress of works, supervision any re-testing, coordination with third parties for commissioning & certification, organizing & performing testing for satisfaction of all Statutory Bodies, T&C record documentation & handover

(a) GENERAL

a. Testing, adjusting and balancing of heating, ventilating and air-conditioning systems at site.

b. Testing, adjusting and balancing of HVAC Hydronic system at site.

c. Testing, adjusting and balancing of exhaust system at site.

Comply with current editions of all applicable practices, codes, methods of standards prepared by technical societies and Associations including:

- ASHRAE : 2007 HVAC Application or latest version.
- SMACNA : Manual for the Balancing and Adjustment of air distribution system.

d. AC Contractor shall submit a Test, adjust, balance procedure/method statements/charts for approval to Client.

(b) PERFORMANCE

a. Verify design conformity.

b. Establish fluid flow rates, volumes and operating pressures.

c. Take electrical power readings for each motor.

d. Establish operating sound and vibration levels.

e. Adjust and balance to design parameters.

f. Record and report results as per the formats specified.
(c) DEFINITIONS

a. Test : To determine quantitative performance of equipment.

b. Adjust : To regulate for specified fluid flow rates and air patterns at terminal equipment (e.g. reduce fan speed, throttling etc.)

c. Balance : To proportion within distribution system (submains, Branches and terminals) in accordance with design quantities.

(d) TESTING, ADJUSTING AND BALANCING (TAB) PROCEDURES

The following procedures shall be directly followed in TAB of the total system. Before commencement of each one of the TAB procedure explained hereunder, the AC Contractor shall intimate the Client about his readiness to conduct the TAB procedures in the format given in these specifications.

(e) DESCRIPTION OF SYSTEM AND REQUIREMENTS

Adjust and balance the following system to provide most energy efficient operation compatible with selected operating conditions.

a. All supply, return and outside air systems.

b. All exhaust air systems.

c. All chilled water systems.

d. All cooling tower (condenser) water systems.

e. Emergency purge systems.

(f) AIR SYSTEMS

I. Air Handlers Performance

The TAB procedure shall establish the right selection and performance of the AHUs with the following results:

a. Air-IN DB and WB temperature.

b. Air-OUT DB and WB temperature.

c. Dew point air leaving.

d. Sensible heat flow.

e. Latent heat flow.

f. Sensible heat factor.

g. Fan air volume.

h. Fan air outlet velocity.

i. Fan static pressure.

j. Fan power consumption.

k. Fan speed.

II. Air distribution

Both supply and return air distribution for each AHU and for areas served by the AHU shall be determined and adjusted as necessary to provide design air quantities. It shall cover balancing of air through main and branch ducts.

III. The Preparatory Work
To conduct the above test, following preparatory works are required to be carried out including the availability of approved for construction shop drawings and submittals:

a. All outside air intake, return air and exhaust air dampers are in proper position.
b. All system volume dampers and fire dampers are in full open position.
c. All access doors are installed & are air tight.
d. Grilles are installed & dampers are fully open.
e. Provision and accessibility of usage of TAB instruments for traverse measurements are available.
f. All windows, doors are in position.
g. Duct system is of proper construction and is equipped with turning vanes and joints are sealed.
h. Test holes and plugs for ducting.

(g) HYDRONIC SYSTEM BALANCING

I. The Hydronic system shall involve the checking and balancing of all water pumps, piping network (main & branches), the heat exchange equipment like cooling and heating coils, condensers and chillers and cooling towers in order to provide design water flows.

II. The essential preparation work, must be done by the HVAC Contractor prior to actual testing, adjusting and balancing of HVAC system and ensure following:

• Availability of co-ordinated drawings and approved submittals and system sketch with design water flows specified thereon.
• Hydronic system is free of leaks, is hydrostatically tested and is thoroughly cleaned, flushed and refilled.
• Hydronic system is vented.

III. The AC Contractor shall confirm completion of the basic procedures and prepare check lists for readiness of system balance.

a. Check pumps operation for proper rotation and motor current drawn etc.
b. Confirm that provisions for TAB measurements (Temperature, pressure and flow measurements) have been made.
c. Open all shut-off valves and automatic control valves to provide full flow through coils. Set all balancing valves in the preset position, if these values are known. If not, shut all riser balancing valves except the one intended to be balanced first.

Balancing work for both Chilled Water System and Condenser Water System shall be carried out in a professional manner and test reports in the specified format shall be prepared and presented to the Client / Consultant for endorsement.

(h) READINESS FOR COMMENCEMENT OF TAB

Before starting of any of the tests, the readiness to do so should be recorded as per the prescribed check list.

(i) TAB INSTRUMENTS

I. Air Measuring Instruments

a. For measuring DB and WB temperature, RH and dew point, microprocessor based TSI USA make VelociCalc Plus Meter, Model 8386, or equivalent shall be used. This
instrument shall be capable of calculating the sensible, latent total heat flows, sensible heat factor and give printouts at site and have data logging/downloading facility.

b. For measuring Air velocity, DB temperature and Air volume, TSI USA make VelociCalc meter model 8386/8345 or equivalent shall be used. It shall be able to provide instant print out of recorded Air volume readings.

c. Pitot tube.

d. Electronic Rotary Vane Anemometer TSI make or equivalent.

e. Accubalance Flow Measuring Hood TSI make or equivalent.

[All above instruments shall have a valid certification from a reputed testing institution.]

II. Hydronic Measuring Instruments

a. For measurement of water flow across balancing valves, instruments as provided by the manufacturer of the valves specific to the type of valves shall be need. This shall include but not be limited to differential pressure manometers. Temperature shall be measured using electric thermometers from thermowells provided at strategic location by the HVAC Contractor. The water balancing shall be carried out being computer simulation program provided / certified by the balancing valve manufacturer.

III. Rotation Measuring Instrument

a. Electronic Digital Tachometer.

IV. Temperature & RH Measuring Instrument

a. TSI VelociCalc model 8386 / VelociCalc model 8345 or equivalent.

V. Electrical Measuring Devices

a. Clamp on Volt ammeter.

b. Continuity Meter.

VI. Vibration and Noise Levels

Vibration and alignment field measurements shall be taken for each circulating water pump, water chilling unit, air handling unit and fan driven by a motor over 10 HP. Readings shall include shaft alignment, equipment vibration, bearing housing vibration, and other test as directed by the PMC.

Sound level readings shall be taken at ten (10) locations in the building as selected by the Contractor / Client. The readings shall be taken on an Octave Band analyzer in a manner acceptable to him. The AC Contractor shall submit test equipment data and reporting forms for review. In order to reduce the ambient noise level the readings shall be taken at night. All test shall be performed in the presence of Client / Consultant or his authorized representative.

SYSTEM READY TO BALANCE CHECK LIST (NOT LIMITED TO FOLLOWING)

<table>
<thead>
<tr>
<th>Description</th>
<th>Ready</th>
<th>Date Corrected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. HVAC Units (AHU)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. General</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Louvers installed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual dampers open &amp; locked</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automatic dampers set properly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Housing Construction leakage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access doors-leakage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condensate drain piping and pan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Section</td>
<td>Details</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td><strong>Free from dirt and debris</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Nameplate data</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| **b. Filters** | Type and size  
Number  
Clean  
Frame-Leakage |
| **c. Coils (Hydronic)** | Size and rows  
Fin spacing and condition  
Obstructions and / or debris  
Airflow and direction  
Piping leakage  
Correct piping Connections and flow  
Valves open or set  
Air vents or steam traps  
Provision made of TAB Measurements |
| **d. Fans** | Rotation  
Wheel clearance and balance  
Bearing and motor lubrication  
Drive alignment  
Belt tension  
Drive set screws tight  
Belt guard in place  
Flexible duct connector alignment  
Starters and disconnect switches  
Electrical service & connections  
Nameplate data |
| **e. Vibration Isolation** | Springs & Compression  
Base Level & Free |
| **2. Duct System** | |
| **a. General** | Manual dampers open & locked  
Access doors closed and tight  
Fire dampers open and accessible  
Terminal units open and set  
Registers and diffusers open and set  
Turning vanes in square elbows  
Provisions made for TAB measurements  
Systems installed as per plans  
Ductwork sealed as required |
| **b. Architectural** | Windows installed and closed  
Doors closed as required  
Ceiling plenums installed and sealed  
Access doors closed and tight  
Air shafts and openings as required |
| **3. Pumps** | |
| **a. Motors** | |
### Rotation
- Lubrication
- Alignment
- Set screws tight
- Guards in place
- Tank level and controls.
- Starters and disconnect switches
- Electrical service & connections.
- Nameplate data.

### Piping
- Correct flow
- Correct connections
- Leakage
- Valves open or set
- Strainer clean
- Air vented
- Flexible connectors
- Provisions made for TAB measurements

### Bases
- Vibration isolation.
- Grouting
- Leveling

### Hydronic Equipment

#### Heat Exchangers/ HW coil
- Correct flow and connections
- Valves open or set
- Air vents or steam traps
- Leakage
- Provisions made for TAB measurements
- Nameplate data.

#### Refrigeration Equipment
- Crankcase heaters energized
- Operating controls and devices.
- Safety controls and devices.
- Valves open
- Piping connections and flow
- Flexible connectors
- Oil level and lubrication
- Alignment and drives.
- Guards in place.
- Vibration isolation.
- Starters, contactors and disconnect switches.
- Electrical connectors.
- Nameplate data.

### Hydronic Piping systems
- Leak tested.
- Fluid levels and make-up
- Relief or safety valves.
- Compression tanks and air vents.
- Steam traps and connections.
- Strainers clean
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Constructions of AIIMS, Guwahati (Assam)</td>
<td></td>
</tr>
<tr>
<td>Vol-V: Tech Specs</td>
<td></td>
</tr>
<tr>
<td>Tender No. HITES/AIIMS-Guwahati/2018</td>
<td></td>
</tr>
<tr>
<td>Page 523</td>
<td></td>
</tr>
<tr>
<td>7. Controls System</td>
<td></td>
</tr>
<tr>
<td>Data centers.</td>
<td></td>
</tr>
<tr>
<td>Outdoor return air reset</td>
<td></td>
</tr>
<tr>
<td>Economizer</td>
<td></td>
</tr>
<tr>
<td>Static pressure</td>
<td></td>
</tr>
<tr>
<td>Room controls.</td>
<td></td>
</tr>
<tr>
<td>8. Other Checks.</td>
<td></td>
</tr>
<tr>
<td>a. Other trades or personnel notified of TAB work requirements.</td>
<td></td>
</tr>
<tr>
<td>b. Preliminary data complete</td>
<td></td>
</tr>
<tr>
<td>c. Test report forms prepared.</td>
<td></td>
</tr>
</tbody>
</table>

valves open or set
Provisions made for TAB measurements.
Systems installed as per plans.
# INSTRUMENT CALIBRATION REPORT

PROJECT _____________________________________________________

<table>
<thead>
<tr>
<th>S/No</th>
<th>INSTRUMENT/ APPLICATION</th>
<th>DATES OF USE</th>
<th>CALIBRATION TEST DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**REMARKS**

**TEST DATE_________________** **READINGS BY_________________**
# CHILLER TEST REPORT

**PROJECT** __________________________  **UNIT** __________________________

**LOCATION** __________________________

**MANUF.** ______  **MODEL** ___________  **SERIAL NO.** ___________

**CAPACITY** ______  **REFRIG** ______  **STARTER** ______  **HEATER SIZE** ______

<table>
<thead>
<tr>
<th>Description</th>
<th>Design</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) COMPRESSOR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Make / Model</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial No.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type (Reciprocating, Centrifugal, Screw, Scroll)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piping Material</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suction Pr / Tem.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discharge Pr / Temp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refrigerant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Pump Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Failure Switch Pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unload Arrangement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unload Set Points</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compressor Speed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L P Setting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H P Setting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anti Freeze Setting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purge Unit Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purge Operation Checked</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) COMPRESSOR MOTOR</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


## MOTOR STARTER

<table>
<thead>
<tr>
<th>Make / Model</th>
<th>Type</th>
<th>Voltage</th>
<th>Motor Rated Current</th>
<th>Motor F L Current</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## EVAPORATOR

<table>
<thead>
<tr>
<th>Make / Model</th>
<th>No. of Passes</th>
<th>Ref : Level</th>
<th>Ref : Pressure / Temperature</th>
<th>Ent. Water Temp/Pressure</th>
<th>Leaving Water Temp/Pressure</th>
<th>Temperature Difference</th>
<th>Pressure Difference</th>
<th>Water Quantity</th>
<th>Relief Valve Setting</th>
<th>IKW / Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**REMARKS**

**TEST DATE ___________________ READINGS BY __________________**
### COOLING TOWER TEST REPORT

**PROJECT**

**SYSTEM**

**LOCATION**

**MANUF.**

**MODEL**

**SERIAL NO.**

**NOM. CAPACITY**

**WATER TREAT.**

<table>
<thead>
<tr>
<th>Description</th>
<th>Design</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) TOWER / MOTOR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Make / Model</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of Fan Motors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor HP / RPM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor / Drive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor Speed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor Rated Current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor FL Current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O/L Release Setting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT Range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT Approach</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) TOWER / FAN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of Fans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type/ Drive of Fan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fan Dia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fan Speed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Inlet Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Outlet Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fan Air Quantity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Bleed GPM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) TOWER / AIR DATA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fan CFM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>----------------------</td>
<td></td>
</tr>
<tr>
<td>Outlet S.P.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avg. Ent. W.B.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avg. Lvg. W.B.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient W.B.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fan RPM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amps</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

d) TOWER / WATER DATA

| Ent//Lvg./Water Pressure |                      |
| Ent//Lvg./Water Temperature |                      |
| Water Temperature – T    |                      |
| GPM                     |                      |
| Bleed GPM               |                      |
| Voltage                 |                      |
| Amps                    |                      |

**REMARKS**

**TEST DATE ____________**
**READINGS BY ____________________________**
## PUMP TEST REPORT

**PROJECT**

<table>
<thead>
<tr>
<th>DATA</th>
<th>PUMP NO.</th>
<th>PUMP NO.</th>
<th>PUMP NO.</th>
<th>PUMP NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model Number</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial Number</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPM/Head</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Req. NPSH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pump RPM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impeller Dia.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor Mfr. / Frame</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor HP/RPM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volts/Phase/Hertz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F.L Amps</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seal Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pump Off-Press.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valve Shut Diff.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Act.Impeller Dia.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valve Open diff.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valve Open GPM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Dischg. Press.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Suction Press.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Ap</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final GPM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amperage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**REMARKS**

**TEST DATE** ________________ **READINGS BY** ____________________
# AIR HANDLING EQUIPMENT TEST REPORT

## PROJECT

## SYSTEM/UNIT LOCATION

<table>
<thead>
<tr>
<th>Description</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>a) UNIT</strong></td>
<td></td>
</tr>
<tr>
<td>Make/Model No.</td>
<td></td>
</tr>
<tr>
<td>Type/Size</td>
<td></td>
</tr>
<tr>
<td>Serial Number</td>
<td></td>
</tr>
<tr>
<td>Arr./Class</td>
<td></td>
</tr>
<tr>
<td>Discharge</td>
<td></td>
</tr>
<tr>
<td>Pulley dia/Bore</td>
<td></td>
</tr>
<tr>
<td>No. Belts/make/size</td>
<td></td>
</tr>
<tr>
<td>No. Filters/type/size (Pre.)</td>
<td></td>
</tr>
<tr>
<td>No. Filters/type/size (secondary)</td>
<td></td>
</tr>
<tr>
<td><strong>b) MOTOR</strong></td>
<td></td>
</tr>
<tr>
<td>Make / Frame</td>
<td></td>
</tr>
<tr>
<td>H.P / RPM</td>
<td></td>
</tr>
<tr>
<td>Volts/Phase/cycles</td>
<td></td>
</tr>
<tr>
<td>F.L amps.</td>
<td></td>
</tr>
<tr>
<td>Pulley Dia/Bore</td>
<td></td>
</tr>
<tr>
<td>Pulley /Distance.</td>
<td></td>
</tr>
<tr>
<td>Total Cfm</td>
<td></td>
</tr>
<tr>
<td>Total S.P</td>
<td></td>
</tr>
<tr>
<td>Fan RPM</td>
<td></td>
</tr>
<tr>
<td>Motor Volts. T</td>
<td></td>
</tr>
<tr>
<td>Outside air Cfm</td>
<td></td>
</tr>
<tr>
<td>Return air Cfm</td>
<td></td>
</tr>
<tr>
<td>Discharge S.P</td>
<td></td>
</tr>
<tr>
<td>Cooling Coil S.P</td>
<td></td>
</tr>
<tr>
<td>Filters S.P</td>
<td></td>
</tr>
</tbody>
</table>

## REMARKS

**TEST DATE**

**READINGS BY**
**COOLING / HEATING TEST REPORT (AHU)**

**PROJECT**

<table>
<thead>
<tr>
<th>COIL DATA</th>
<th>COIL NO.</th>
<th>COIL NO.</th>
<th>COIL NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coil Type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. Rows Fins/In</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model Number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Face Area, Sq.Ft.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TEST DATA</th>
<th>DESIGN/ACTUAL</th>
<th>DESIGN/ACTUAL</th>
<th>DESIGN/ACTUAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Qty. CFM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Vel.FPM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Press.Drop In.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out.Air DB/WB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ret. Air DB/WB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ent.Air DB/WB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lvg.Air DB/WB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air AT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waer flow. GPM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Press.Drop.PSI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ent.Water Temp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lvg .Water Temp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water AT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exp.Valve/Refrig</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refrig.Suction Pr.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refrig.Suct.Temp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inlet Steam press.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**REMARKS**

**TEST DATE** _____________ **READINGS BY** _________________________
# FAN COIL TEST REPORT

**PROJECT**

**DATE**

**LOCATION**

**MANUFACTURER**

<table>
<thead>
<tr>
<th>AREA SERVED</th>
<th>FCU MAKE</th>
<th>CAPACITY TR</th>
<th>TEMPERATURE DEG. F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GRILLE ROOM</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**REMARKS**

**TEST DATE**

**READINGS BY**

---
# FAN TEST REPORT

## PROJECT

<table>
<thead>
<tr>
<th>FAN DATA</th>
<th>FAN No.</th>
<th>FAN No.</th>
<th>FAN No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model No.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial No.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type / Class</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor Make / Style</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor H.P/RPM/ Frame</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volts/Phase/Cycles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F.L Amps.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor pulley Dia./Bore</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fan pulley Dia./Bore</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. Belts/ Make/Size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulley Distance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CFM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FAN RPM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.P IN/OUT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL S.P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amperage</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## REMARKS

**TEST DATE** ______________ **READINGS BY** _________________________
### RECTANGULAR DUCT TRAVERSE REPORT

**PROJECT** ______________  **SYSTEM** ______________

**LOCATION / ZONE** ______________  **ACTUAL AIR TEMP.** ______________  **DUCT S.P.** ______________

<table>
<thead>
<tr>
<th>DUCT</th>
<th>REQUIRED</th>
<th>ACTUAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIZE</td>
<td>SQ.FT.</td>
<td>FPM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FPM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>POSITION</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**VELOCITY**

**SUBTOTALS**

**REMARKS**

**TEST DATE** ______________  **READINGS BY** __________________________
### GRILLES AND DIFFUSERS TEST REPORT

<table>
<thead>
<tr>
<th>S/No</th>
<th>AREA SERVED</th>
<th>OUTLET NO./TYPE/ SIZE</th>
<th>DESIGN CFM/VEL</th>
<th>PRLIMINARY CFM/VEL</th>
<th>FINAL CFM/VEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### REMARKS

TEST DATE______ READINGS BY _________________________

### 33. 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 Colouring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed Duct Work (other than plant room)</td>
<td>As per E-I-C Directions</td>
<td>As per E-I-C Directions</td>
</tr>
<tr>
<td>Air Conditioning Duct Work (Plant Rooms)</td>
<td>BSS 111 Pale Blue</td>
<td>Black</td>
</tr>
<tr>
<td>Ventilation Duct Work (Plant Rooms)</td>
<td>BSS 111 Pale Blue</td>
<td>Black</td>
</tr>
<tr>
<td>Conditioner Casings Air Handling Units, Filter Plenums</td>
<td>BSS 111 Pale Blue</td>
<td>Black</td>
</tr>
<tr>
<td>Electrical (Conduit Ducts and Motors)</td>
<td>BSS 557 Light Orange</td>
<td>Black</td>
</tr>
<tr>
<td>Chilled Water Pipe</td>
<td>Jade Green</td>
<td>Black</td>
</tr>
<tr>
<td>Drains</td>
<td>Black</td>
<td>White</td>
</tr>
<tr>
<td>Vents</td>
<td>Black</td>
<td>Black</td>
</tr>
<tr>
<td>Fans</td>
<td>BSS 111 Pale Blue</td>
<td>Black</td>
</tr>
<tr>
<td>Valves and Pipe Line Fittings</td>
<td>White with black handles</td>
<td>Black</td>
</tr>
<tr>
<td>Beltquards</td>
<td>Black and yellow diagonal stripes (45 25 mm wide)</td>
<td>Black</td>
</tr>
<tr>
<td>Switchboards- exterior – interior</td>
<td>BS 366 Light Beige</td>
<td>White</td>
</tr>
<tr>
<td>Machine Bases, Inertia Bases and Plinths</td>
<td>Charcoal</td>
<td>Grey</td>
</tr>
<tr>
<td>Chilling M/C</td>
<td>As Per Manufacturer's Standard</td>
<td></td>
</tr>
<tr>
<td>Pump-sets</td>
<td>Battle ship grey</td>
<td></td>
</tr>
<tr>
<td>Condenser water pipes</td>
<td>Light green</td>
<td>Black</td>
</tr>
<tr>
<td>Electrical panels/sub-panel/ remote control console</td>
<td>Light grey powder coated</td>
<td>RAL 7032 as per DIN</td>
</tr>
<tr>
<td>Supports for ducts</td>
<td>Silver</td>
<td></td>
</tr>
</tbody>
</table>

## 34. IDENTIFICATION OF SERVICES

### GENERAL

This section comprises of identification of services for each piece of equipment

### VALVE LABELS AND CHARTS

Each valve shall be provided with a label indicating the service being controlled, together with a reference number corresponding with that shown on the Valve Charts and “as fitted” drawings. The labels shall be made from 3 ply (black / white/ black) Traffolyte material showing white letters and figures on a black background. Labels to be tied to each valve with chromium plated linked chain. The labels shall be suitable for minimum 40 characters with font size of 24 minimum. Labelling scheme of each equipment to be submitted for approval from Client / Consultant.

A wall mounted, glass covered plan to the endorsement of the Client / Consultant shall be provided and displayed in each plant room showing the plant layout with pipe work, valve diagram and valve schedule indicating size, service, duty, etc.
All AC equipments shall be provided with permanent mounted identification labels and unique tagging numbers. The shop drawings shall also include these tagging numbers for easy identification on site. It should be co-ordinated with BMS also to ensure consistent equipment tagging among drawings, BMS display and site installation.

**IDENTIFICATION OF SERVICES**

Pipe work and duct work shall be identified by colour bands 150 mm. wide or colour triangles of at least 150 mm. / side. The bands of triangles shall be applied at termination points, junctions, entries and exits of plant rooms, walls, in ceiling spaces, ducts and control points to readily identify the service, but spacing shall not exceed 4.0 metres.

**PIPE WORK SERVICES**

For pipe work services and its insulation the colours of the bands shall comply with BS.1710: 1971. Basic colours for pipe line identification:

<table>
<thead>
<tr>
<th>Pipe Line Contents</th>
<th>BS. 4800 Colour Reference</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>12 D 45</td>
<td>Green</td>
</tr>
<tr>
<td>Steam</td>
<td>10 A 03</td>
<td>Grey</td>
</tr>
<tr>
<td>Oils</td>
<td>06 C 39</td>
<td>Brown</td>
</tr>
<tr>
<td>Gas</td>
<td>08 C 35</td>
<td>Yellow / Brown</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pipe Line Contents</th>
<th>BS. 4800 Colour Reference</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>20 E 51</td>
<td>Blue</td>
</tr>
<tr>
<td>Drainage</td>
<td>00 E 53</td>
<td>Black</td>
</tr>
<tr>
<td>Electrical</td>
<td>06 E 51</td>
<td>Orange</td>
</tr>
</tbody>
</table>

Colour code indicator bands shall be applied as colour bands over the basic identification colour in the various combinations as listed below:

<table>
<thead>
<tr>
<th>Pipe Line Contents</th>
<th>Colour Bands to BS. 4800</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water Services:</strong></td>
<td></td>
</tr>
<tr>
<td>Cooling</td>
<td>00 E 55</td>
</tr>
<tr>
<td>Fresh / drinking</td>
<td>18 E 53</td>
</tr>
<tr>
<td>Boiler feed</td>
<td>04 D 45 / 00 E 55 / 04 D 45</td>
</tr>
<tr>
<td>Condensate</td>
<td>04 D 45 / 14 E 53 / 04 D 45</td>
</tr>
<tr>
<td>Chilled</td>
<td>00 D 55 / 14 E 53 / 00 D 45</td>
</tr>
<tr>
<td><strong>Central Heating Services:</strong></td>
<td></td>
</tr>
<tr>
<td>Below 100 Deg. C</td>
<td>18 E 55 / 04 D 45 / 18 E 53</td>
</tr>
<tr>
<td>Above 100 Deg. C</td>
<td>04 D 45 / 18 E 53 / 04 D 45</td>
</tr>
<tr>
<td><strong>Cold Water Storage</strong></td>
<td></td>
</tr>
<tr>
<td>Tanks</td>
<td>00 E 55 / 18 E 53 / 00 E 55</td>
</tr>
<tr>
<td>Hot Water Supply</td>
<td>00 E 55 / 04 D 45 / 00 E 55</td>
</tr>
<tr>
<td>Pipe Line Contents</td>
<td>Colour Bands to BS. 4800</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Hydraulic Power</td>
<td>04 C 33</td>
</tr>
<tr>
<td>Sea / River Untreated</td>
<td>Basic Colour only</td>
</tr>
<tr>
<td>Fire Extinguishing</td>
<td>04 E 53</td>
</tr>
<tr>
<td><strong>Steam Services :</strong></td>
<td>Basic Colour only</td>
</tr>
<tr>
<td>Air : Compressed</td>
<td>Basic Colour only</td>
</tr>
<tr>
<td>Vacuum</td>
<td>White</td>
</tr>
<tr>
<td><strong>Town Gas : Manufactured</strong></td>
<td>14 E 53</td>
</tr>
<tr>
<td>Natural</td>
<td>10 E 53</td>
</tr>
<tr>
<td><strong>Oils :</strong></td>
<td></td>
</tr>
<tr>
<td>Diesel</td>
<td>00 E 55</td>
</tr>
<tr>
<td>Lubricating</td>
<td>14 E 53</td>
</tr>
<tr>
<td>Hydraulic Power</td>
<td>04 C 53</td>
</tr>
<tr>
<td>Transformer</td>
<td>04 D 45</td>
</tr>
<tr>
<td><strong>Drainage and other fluids :</strong></td>
<td>Basic Colour only</td>
</tr>
<tr>
<td>Electrical Services :</td>
<td>Basic Colour only</td>
</tr>
</tbody>
</table>

In addition to the colour bands specified above all pipe work shall be legibly marked with black or white letters to indicate the type of service and the direction of flow, identified as follows:

- High Temperature Hot Water         HTHW
- Medium Temperature Hot Water       MTHW
- Low Temperature Hot Water          LTHW
- Chilled Water                      CHW
- Condenser Water                    CONDW
- Steam                              ST
- Condensate                         CN

Pipe shall have the letters F and R added to indicate flow and return respectively as well as directional arrows.

**DUCT WORK SERVICES :**

For Duct work services and its insulation the colours of the triangles shall comply with BS.1710 : 1971. The size of the symbol will depend on the size of the duct and the viewing distance but the minimum size should not be less than 150 mm. length per side. One apex of the triangle shall point in the direction of airflow.

<table>
<thead>
<tr>
<th>Services</th>
<th>Colour</th>
<th>BS.4800 Colour Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditioned Air</td>
<td>Red and Blue</td>
<td>04 E 53 / 18 E 53</td>
</tr>
<tr>
<td>Service Type</td>
<td>Color</td>
<td>Code</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>--------</td>
<td>-------</td>
</tr>
<tr>
<td>Ward Air</td>
<td>Yellow</td>
<td>10 E 53</td>
</tr>
<tr>
<td>Outdoor Air</td>
<td>Green</td>
<td>14 E 53</td>
</tr>
<tr>
<td>Exhaust / Extract / Recirculated Air</td>
<td>Grey</td>
<td>AA 0 09</td>
</tr>
<tr>
<td>Foul Air</td>
<td>Brown</td>
<td>06 C 39</td>
</tr>
<tr>
<td>Dual Duct System Hot Supply Air</td>
<td>Red</td>
<td>04 E 53</td>
</tr>
<tr>
<td>Cold Supply Air</td>
<td>Blue</td>
<td>18 E 53</td>
</tr>
</tbody>
</table>

In addition to the colour triangles specified above all duct work shall be legibly marked with black or white letters to indicate the type of service, identified as follows:-

Supply Air  S
Return Air  R
Outdoor Air  O
Exhaust Air  E
Smoke Extract Duct  M
Spill Air  A

The colour banding and triangles shall be manufactured from self adhesive cellulose tape, laminated with a layer of transparent ethyl cellulose tape.

LIST OF ABBREVIATIONS

Followings List of Abbreviations shall have been used in preparing the Tender Specifications, DBR & Drawings.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AABC</td>
<td>AMERICAN AIR BALANCING COUNCIL</td>
</tr>
<tr>
<td>ACH</td>
<td>AIR CHANGE PER HOUR</td>
</tr>
<tr>
<td>AC</td>
<td>AIR CONDITIONING</td>
</tr>
<tr>
<td>ACMV</td>
<td>AIR CONDUCTING AND MECHANICAL VENTILATION</td>
</tr>
<tr>
<td>AHU</td>
<td>AIR HANDLING UNIT</td>
</tr>
<tr>
<td>ANSI</td>
<td>AMERICAN NATIONAL STANDARD INSTITUTE</td>
</tr>
<tr>
<td>ARI</td>
<td>AMERICAN REFRIGERATION INSTITUTE</td>
</tr>
<tr>
<td>ASHRAE</td>
<td>AMERICAN SOCIETY OF HEATING, REFRIGERATION AND AIRCONDITIONING ENGINEER</td>
</tr>
<tr>
<td>ASME</td>
<td>AMERICAN SOCIETY OF MECHANICAL ENGINEERS</td>
</tr>
<tr>
<td>ASTA</td>
<td>ASSOC.CIATION OF SHORT - CIRCUIT TESTING AUTHORITIES</td>
</tr>
<tr>
<td>ASTM</td>
<td>AMERICAN SOCIETY OF TESTING AND MATERIALS</td>
</tr>
<tr>
<td>ATG</td>
<td>AIR TRANSFER GRILLE</td>
</tr>
<tr>
<td>AWS</td>
<td>AMERICAN WELDING SOCIETY</td>
</tr>
<tr>
<td>BAS</td>
<td>BUILDING AUTOMATION SYSTEM</td>
</tr>
<tr>
<td>BIS</td>
<td>BUREAU OF INDIAN STANDARD</td>
</tr>
<tr>
<td>BMS</td>
<td>BUILDING MANAGEMENT SYSTEM</td>
</tr>
<tr>
<td>BTU</td>
<td>BRITISH THERMAL UNIT</td>
</tr>
<tr>
<td>CDW</td>
<td>CONDENSER WATER</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>CFM</td>
<td>CUBIC FEET PER MINUTE</td>
</tr>
<tr>
<td>CHW</td>
<td>CHILLED WATER</td>
</tr>
<tr>
<td>CMS</td>
<td>CENTRAL MONITORING SYSTEM</td>
</tr>
<tr>
<td>CRCA</td>
<td>COLD ROLLED COLD ANNEALED</td>
</tr>
<tr>
<td>CSA</td>
<td>CANADIAN STANDARD ASSOCIATION</td>
</tr>
<tr>
<td>CT</td>
<td>COOLING TOWER</td>
</tr>
<tr>
<td>CTI</td>
<td>COOLING TOWER INSTITUTE</td>
</tr>
<tr>
<td>DB</td>
<td>DISTRIBUTION BOARD</td>
</tr>
<tr>
<td>DDC</td>
<td>DIRECT DIGITAL CONTROLLER</td>
</tr>
<tr>
<td>DOL</td>
<td>DIRECT ON LINE</td>
</tr>
<tr>
<td>DFA</td>
<td>DELHI FIRE AUTHORITY</td>
</tr>
<tr>
<td>DIA</td>
<td>DIAMETER</td>
</tr>
<tr>
<td>DIDW</td>
<td>DOUBLE INLET DOUBLE WIDTH</td>
</tr>
<tr>
<td>DX</td>
<td>DIRECT EXPANSION</td>
</tr>
<tr>
<td>EA</td>
<td>EXHAUST AIR</td>
</tr>
<tr>
<td>EEPROM</td>
<td>ELECTRICAL ERASABLE PROGRAM</td>
</tr>
<tr>
<td>ELCB</td>
<td>EARTH LEAKAGE CIRCUIT BREAKER</td>
</tr>
<tr>
<td>ETL</td>
<td>ELECTRICAL TESTING LABORATORIES</td>
</tr>
<tr>
<td>EPA</td>
<td>ENVIRONMENTAL PROTECTION ACT</td>
</tr>
<tr>
<td>FCU</td>
<td>FAN COIL UNIT</td>
</tr>
<tr>
<td>F/A</td>
<td>FLOOR ABOVE</td>
</tr>
<tr>
<td>F/B</td>
<td>FLOOR BLOW</td>
</tr>
<tr>
<td>FCC</td>
<td>FIRE COMMAND CENTRE</td>
</tr>
<tr>
<td>FD</td>
<td>FIRE DAMPER</td>
</tr>
<tr>
<td>FFL</td>
<td>FINISHED FLOOR LEVEL</td>
</tr>
<tr>
<td>FPM</td>
<td>FEET PER MINUTE</td>
</tr>
<tr>
<td>FPS</td>
<td>FOOT PER SECOND</td>
</tr>
<tr>
<td>FRP</td>
<td>FIBERGLASS REINFORCED PLASTIC</td>
</tr>
<tr>
<td>GI</td>
<td>GALVANISED IRON</td>
</tr>
<tr>
<td>GPM</td>
<td>GALLON PER MINUTE</td>
</tr>
<tr>
<td>GSS</td>
<td>GALVANIZED STEEL SHEET</td>
</tr>
<tr>
<td>H/L</td>
<td>HIGH LEVEL</td>
</tr>
<tr>
<td>HDG</td>
<td>HOT DIP GALVANIZED</td>
</tr>
<tr>
<td>HDPE</td>
<td>HIGH DENSITY POLY ETHANE</td>
</tr>
<tr>
<td>HFC</td>
<td>HYDRO FLURO CARBON</td>
</tr>
<tr>
<td>HP</td>
<td>HORSE POWER</td>
</tr>
<tr>
<td>HVAC</td>
<td>HEATING, VENTILATION &amp; AIR CONDITIONING</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------</td>
<td>------------</td>
</tr>
<tr>
<td>IAQ</td>
<td>INDOOR AIR QUALITY</td>
</tr>
<tr>
<td>IEC</td>
<td>INTERNATIONAL ELECTROCHEMICAL COMMISSION</td>
</tr>
<tr>
<td>IKW</td>
<td>INDICATED KILO WATT</td>
</tr>
<tr>
<td>IPD</td>
<td>INITIAL PRESSURE DROP</td>
</tr>
<tr>
<td>ISO</td>
<td>INTERNATIONAL STANDARD ORGANIZATION</td>
</tr>
<tr>
<td>KW</td>
<td>KILO WATT</td>
</tr>
<tr>
<td>L</td>
<td>LITRE</td>
</tr>
<tr>
<td>LCD</td>
<td>LIQUID CRYSTAL DISPLAY</td>
</tr>
<tr>
<td>L/L</td>
<td>LOW LEVEL</td>
</tr>
<tr>
<td>L/S</td>
<td>LITRE PER SECOND</td>
</tr>
<tr>
<td>LSZH</td>
<td>LOW SMOKE ZERO HALOGEN</td>
</tr>
<tr>
<td>LT</td>
<td>LOW TENSION</td>
</tr>
<tr>
<td>M</td>
<td>METER</td>
</tr>
<tr>
<td>MAX.</td>
<td>MAXIMUM</td>
</tr>
<tr>
<td>MCB</td>
<td>MINIATURE CIRCUIT BREAKER</td>
</tr>
<tr>
<td>MCC</td>
<td>MOTOR CONTROL CENTRE</td>
</tr>
<tr>
<td>MFD</td>
<td>MOTORIZED FIRE DAMPER</td>
</tr>
<tr>
<td>MIN</td>
<td>MINIMUM</td>
</tr>
<tr>
<td>MM</td>
<td>MILLIMETER</td>
</tr>
<tr>
<td>NBC</td>
<td>NATIONAL BUILDING CODE</td>
</tr>
<tr>
<td>NC</td>
<td>NOISE CRITERIA</td>
</tr>
<tr>
<td>NEC</td>
<td>NATIONAL ELECTRIC CODE</td>
</tr>
<tr>
<td>NFPA</td>
<td>NATIONAL FIRE PROTECTION ASSOC.CIATION</td>
</tr>
<tr>
<td>NPLV</td>
<td>NET PART LOAD VALUE</td>
</tr>
<tr>
<td>NIST</td>
<td>NATIONAL INSTITUTE OF STANDARDS &amp; TECHNOLOGY</td>
</tr>
<tr>
<td>NEMA</td>
<td>NATIONAL ELECTRICAL MANUFACTURERS ASSOC.CIATION</td>
</tr>
<tr>
<td>NPSH</td>
<td>NET POSITIVE SUCTION HEAD</td>
</tr>
<tr>
<td>NTS</td>
<td>NOT TO SCALE</td>
</tr>
<tr>
<td>OA</td>
<td>OUTDOOR AIR</td>
</tr>
<tr>
<td>PHE</td>
<td>PUBLIC HEALTH ENGINEERING</td>
</tr>
<tr>
<td>PLC</td>
<td>PROGRAMMABLE LOGIC CONTROLLER</td>
</tr>
<tr>
<td>P.C.</td>
<td>PERSONAL COMPUTER</td>
</tr>
<tr>
<td>PSIG</td>
<td>POUNDS PER SQUARE INCH GAUGE</td>
</tr>
<tr>
<td>PUF</td>
<td>POLYURETHANE FOAM</td>
</tr>
<tr>
<td>RA</td>
<td>RETURN AIR</td>
</tr>
<tr>
<td>RAD</td>
<td>RETURN AIR DUCT</td>
</tr>
<tr>
<td>RCC</td>
<td>REINFORCED CEMENT CONCRETE</td>
</tr>
</tbody>
</table>
35. Noise & Vibration Control

1. Scope of Work

This section deals with design, supply, installation, testing and commissioning of noise and vibration control equipment and accessories.

2. 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:

- BS 4718: 1971 Methods of Test of Silencers for Air Distribution Systems
- BS 2750: Laboratory and Field Measurement of Airborne Sound
  Parts 1-9: 1980 Insulation of Various Building Elements
  Recommendations for Field Laboratory Measurement of Airborne and Impact Sound Transmission in Buildings
- BS 3638: 1987 Methods of Measurement of Sound Adsorption in a Reverberation
Room

BS 4773: Acoustic Testing.
Part 2: 1976

BS 4856: Acoustic performance without additional ducting of forced fan convection equipment.
Part 2: 1976

BS 4857: Acoustic performance with additional ducting of forced fan convection equipment.
Part 5: 1976

BS 4857: Acoustic Testing and Rating of High Pressure Terminal Reheat Units.

BS 4954: Acoustic Testing and Rating of Induction Units.

BS 5643: 1984 Glossary of Refrigeration, Heating, Ventilating and Air Conditioning Terms

3. 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.

Ambient noise from cooling tower also shall be assessed to determine the suitable attenuators that can reduce the noise so as not affecting the adjoining public area.

4. 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
Construc

Construc

Vol- V: Tech Specs

Tender No. HITES/AIIMS-Guwahati/2018

Page 544

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.

5. 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: -Enclosed Spring Mounting (Caged or Restrained Springs) Each mounting shall consist of cast or fabricated telescopic top and bottom housing enclosing one or more helical steel springs as the principle isolation elements, and shall incorporate a built-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 snubbing 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.

6. 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 top and bottom plates, and shall have an outside diameter of not less than 75% of the operating height, and shall be selected to have at least 50% overload capacity before becoming coil bound. The bottom plate shall have bonded to it a neoprene pad designed to attenuate any high frequency energy transmitted by the springs.

7. 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.

8. 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 re-enforced 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.

9. REFERENCE DESIGN STANDARD

Following standard & guidelines shall be adopted while designing the HVAC System.

i) National Building Code of India (NBC 20016) with latest revision.

ii) Energy Conservation Building Code (ECBC 2007) or latest

iii) ASHRAE latest Hand Books.
   a) Fundamentals
   b) HVAC Systems and Equipment
   c) HVAC Applications
   d) Refrigeration

iv) Duct construction standards as per relevant latest BIS codes & SMACNA standards.

v) Air filters as per ASHRAE 52.1-1992 or latest and 52.2-2007 or latest

vi) Indoor Air quality as per ASHRAE 62.1-2010 or latest

vii) Motors, Cabling, Wiring and accessories as per latest BIS codes.

viii) National Electric Codes (NEC) latest version


x) ASHRAE standard 55: Thermal Comfort.

10. BIS CODE & GUIDELINES

Following are the few list of Bureau of Indian Standards Codes for guidelines.

<table>
<thead>
<tr>
<th>IS</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS : 554 - 1985 (Reaffirmed 1996)</td>
<td>Dimensions for pipe threads where pressure tight joints are required on the threads.</td>
</tr>
<tr>
<td>IS : 694 - 1990 (Reaffirmed 1994)</td>
<td>PVC insulated (HD) electric Cables for working voltage unto and including 1100 volts.</td>
</tr>
<tr>
<td>IS : 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>IS : 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>IS : 1554 - 1988 (Part – I)</td>
<td>PVC insulated (Heavy Duty) electric cables for working</td>
</tr>
</tbody>
</table>
36. SAFETY CODES

1. SCOPE

The scope of this sub-section is the minimum safety requirements to be observed during manufacture and erection of the HVAC system as specified herein in addition to the safety norms generally followed:-

2. I.S. STANDARDS

The safety code for mechanical refrigeration IS: 660 and safety code for air conditioning IS: 659 shall be observed.

3. SAFETY REQUIREMENTS

Some of the important safety requirements are as under but not limited to the same:-

a. There shall be maintained in a readily accessible place, first aid appliances including adequate supply of sterilized dressings and cotton wool.
b. The injured person shall be taken to a public hospital without loss of time.

c. Suitable and strong scaffolds shall be provided for workmen for all works that cannot be safely done from ground.

d. No portable single ladder shall be over 8 meters in length. The width between side rails shall not be less than 30 cm (clear) and the distance between two adjacent rings shall not be more than 30 cms, when a ladder is used, an extra mazdoor shall be engaged for holding the ladder.

e. The excavated material shall not be placed within 1.5 meters of the edge of the trench or half of the depth of trenches whichever is more. All trenches and excavations shall be provided with necessary fencing and lighting.

f. Every opening in the floor of a building or in a working platform to be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be one meter.

g. No. Floor, roof or other part of the structure shall be so overloaded with debris or material as to render it unsafe.

h. Workers employed on mixing and handling materials such as asphalt, cement mortar or concrete & lime mortar shall be provided with protective footwear and rubber hand gloves.

i. Those engaged in welding works shall be provided with protective eye shields and glove.

j. No paint containing lead or lead products to be used except in the form of paste or readymade paint.

k. Suitable facemasks shall be supplied for use of workers when the paint is applied in the form of spray or surface having lead paint dry rubbed and scraped.

l. Overalls shall be supplied by the Contractor to the painter and adequate facilities shall be provided to enable the working painter to wash during cessation of the work.

m. The ropes used in hoisting or lowering material or as a means of suspension, shall be of adequate quality and adequate strength and free from defects.

n. All site personnel shall wear safety helmets whenever they are in the construction/erection areas.
**TEST READINGS**

**CHILLER TEST REPORT**

PROJECT________________________________________________________

UNIT___________________________________________________________

LOCATION________________________________________________________________

MANUFACTURER_____________________________________________________

MODEL__________________SERIAL NO.________________________

CAPACITY__________________REFRIGERANT_______________________

STARTER__________________HEATER SIZE_________________________

<table>
<thead>
<tr>
<th>COMPRESSOR</th>
<th>DESIGN</th>
<th>ACTUAL</th>
<th>MOTOR STARTER</th>
<th>DESIGN</th>
<th>ACTUAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make/Model</td>
<td>Make/Model</td>
<td>Type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial No.</td>
<td>Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type (Reciprocating / Centrifugal / Screw / Scroll)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piping Material</td>
<td>Amps</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suction Pr/Tem</td>
<td>O/L Release Range</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discharge Pr/Tem</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refrigerant</td>
<td>EVAPORATOR</td>
<td>DESIGN</td>
<td>ACTUAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Pump Type</td>
<td>Make/Model</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Pressure</td>
<td>No. of Passes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Failure Switch Pressure</td>
<td>Ref. Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unload Arrangement</td>
<td>Ref: Pressure/ Temperature</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unload Set Points</td>
<td>Ent. Water Temp/ Pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drive</td>
<td>Leaving Water Temp/ Pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compressor Speed</td>
<td>Temperature Difference</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Level</td>
<td>Pressure Difference</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Temperature</td>
<td>Water Quantity GPM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L P Setting</td>
<td>Relief Valve Setting</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>H P Setting</td>
<td>IKW / Ton</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anti Freeze Setting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purge Unit Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purge Operation Checked</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Make/Model Make/Model</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>No. of Passes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage</td>
<td>Ref: Pressure/ Temperature</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor Rated Current</td>
<td>Ent. Water Temp/ Pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMPRESSOR MOTOR DESIGN ACTUAL CONDENSER DESIGN ACTUAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of Fans</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor F L Current</td>
<td>Fan Material</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fan Diameter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REMARKS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TEST DATE ________________________________

READING BY ________________________________

Note: Please Furnish test report for all chillers separately.
# PUMP TEST REPORT

**PROJECT ________________________________**

<table>
<thead>
<tr>
<th>DATA</th>
<th>PUMP NO</th>
<th>PUMP NO</th>
<th>PUMP NO</th>
<th>PUMP NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model Number</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial Number</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPM/Head</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Req. NPSH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pump RPM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impeller</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mfr./Frame</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mfr./Frame</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor HP/RPM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volts/Phase/Hertz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F.L Amps</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seal Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pump Off-Press</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valve Shut Diff</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actual Impeller Dia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valve Open differential</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valve Open GPM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Dischg.Pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Suction Pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Δp</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final GPM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amperage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**REMARKS**

**TEST DATE _________________________ READINGS BY_________________________**

*Note: Please Furnish test report for all CHW pumps.*
## AIR HANDLING EQUIPMENTS TEST REPORT

**PROJECT** ______________________  **SYSTEM / UNIT** ______________________

**LOCATION** ______________________

<table>
<thead>
<tr>
<th>UNIT</th>
<th>DATA</th>
<th>MOTOR</th>
<th>DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make/Motor No.</td>
<td>Make / Frame</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type/Size</td>
<td>H.P / RPM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial Number</td>
<td>Volts/Phase/Cycles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arr./Class</td>
<td>F.Lamps.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discharge</td>
<td>Pulley Dia/Bore</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulley dia/ Bore</td>
<td>Pulley/ Distance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. Belts/make/Size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.Filters/type.Size (Pre.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.Filters/type.Size (secondary)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TEST DATA

<table>
<thead>
<tr>
<th>TOTAL CFM</th>
<th>DESIGN</th>
<th>ACTUAL</th>
<th>DESIGN</th>
<th>ACTUAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge S.P</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total S.P</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling Coil S.P</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filters S.P</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out air Cfm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Return air Cfm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### REMARKS.

**TEST DATE** ___________________________________________

**READINGS BY** ______________________

---

**Note**: Please Furnish above report for all AHU.
## RECTANGULAR DUCT TRAVERSE REPORT

**PROJECT________________________**  **SYSTEM________________________**

**LOCATION / ZONE________________**  **ACTUAL AIR TEMP.________________**  **DUCT S.P.________________**

<table>
<thead>
<tr>
<th>DUCT SIZE</th>
<th>REQUIRED FPM</th>
<th>ACTUAL FPM</th>
<th>REQUIRED CFM</th>
<th>ACTUAL CFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQ.FT.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>POSITION</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></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>
<td></td>
<td></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>
<td></td>
<td></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>
<td></td>
<td></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>
<td></td>
<td></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>
<td></td>
<td></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>
<td></td>
<td></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>
<td></td>
<td></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>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**VELOCITY SUBTOTALS**
GRILLES AND DIFFUSERS TEST REPORT

PROJECT ______________________________________________

SYSTEM ______________________________________________

OUTLET MANUFACTURER _________________________________

TEST APPARATUS _______________________________________

<table>
<thead>
<tr>
<th>REA</th>
<th>OUTLET</th>
<th>DESIGN</th>
<th>INITIAL</th>
<th>FINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>SERVED NO</td>
<td>TYP</td>
<td>SIZE</td>
<td>VEL</td>
<td>CFM</td>
</tr>
</tbody>
</table>

REMARKS.

TEST DATE _______________ READINGS BY _______________________

Note: Please Furnish above report for all grills/diffusers with S.No. marked on respective drawings.
37. MODES OF MEASUREMENTS:- The scope of measurement indicated herein below shall be maintained by the Contractor for the purpose of record measurement. The E-I-C, if required, may seek the details of these measurements for verification etc.

i. THE SCOPE OF WORK SHALL INCLUDE THE FOLLOWING:

All equipments, machinery, apparatus and materials required as well as the cost of any tests which the HITES may request in addition to the tests generally required to prove quality and performance of the equipments.

All the labour required supplying and installing the complete installation in accordance with the specifications.

Use of any tools, equipments, 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 equipments foundations from the building structure, wherever necessary. Storage and insurance of all equipments apparatus and materials.

The Contractor’s quoted price shall include all equipments, apparatus, material and labour indicated in the drawings and/or specifications in conjunction with the item in question, as well as all additional equipments, apparatus, material and labour usual and necessary to make in question on its own (and within the system as a whole) complete even though not specifically shown, described or otherwise referred to.

ii. MEASUREMENTS OF SHEET METAL DUCTS, GRILLES/DIFFUSERS ETC.

a. Sheet Metal Ducts

Duct Work shall be measured on the basis of external surface area of ducts. Duct measurements shall be taken before application of the insulation. The external surface areas shall be calculated by measuring the perimeter comprising overall width and depth, including the corner joints, in the center of each duct section, multiplying with the overall length from flange face to flange face of each duct section and adding up areas of all duct sections.

Plenums shall also be measured in similar manner.

For tapered rectangular ducts, the average width and depth shall be considered for perimeter, whereas for tapered circular ducts, the diameter of the section midway large and small diameter shall be adopted, the length of tapered duct section shall be the center line distance between the flanges of the duct section.

For special pieces like bends, tees, reducers, branches and collars, mode of measurement shall be identical to that described above using the length along the centerline.

The quoted unit rate for external surface of ducts shall include all wastage allowances, flanges and gaskets for joints, nuts and bolts, hangers and angles with double nuts for supports, rubber strip 3 mm thick between duct and support, vibration isolator suspension where specified or required, inspection chamber / access panel.

Splitter damper with quadrant and lever for position indication, turning vanes, straightening vanes, and all other accessories required to complete the duct installation as per the Specifications. These accessories shall NOT be separately measured nor paid for.

b. Grilles/Diffusers

Grilles and registers - width multiplied by height, excluding flanges. Volume control dampers shall form part of the unit rate for registers and shall not be separately accounted.
Diffusers - cross section area for airflow at discharge areas, excluding flanges. Volume control dampers shall form part of unit rate for supply air diffusers and shall not be separately accounted.

Linear diffusers - shall be measured by cross-sectional areas and shall exclude flanges for mounting of linear diffusers. The supply air plenum for linear diffusers shall be measured with ducting as described earlier.

Fire dampers - shall be measured by their cross sectional areas perpendicular to the direction of airflow. Quoted rates shall include the necessary collars and flanges for mounting, inspection pieces with access door, electrical actuators and panel. No special allowance shall be payable for extension of cross section outside the air stream.

Flexible connections - shall be measured by their cross sectional areas perpendicular to the direction of airflow. Quoted rates shall include the necessary mounting arrangement, flanges, nuts and bolts and treated-for-fire requisite length of canvas cloth.

Exhaust Hoods - shall be measured by their cross sectional area at the capture point of fumes, parallel to the surface of kitchen equipments. Quoted rates shall include the grease filters, provision for hood light, suspension arrangement for the hood, profile to direct the air to ventilation ducts and provision for removable drip tray.

c. **DAMPERS**: Measurement of dampers shall be as per internal cross sectional area of the damper.

d. **MEASUREMENTS OF PIPING, FITTINGS, VALVES, FABRICATED ITEMS**

I. **PIPES**

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, reducers, elbows etc. Deduction shall be made for valves in the line.

The rate quoted shall be inclusive of cutting holes, exposing reinforcement in wall and ceiling and floors and making good the same and inclusive of all items as specified in specifications and DBR.

Rates quoted shall be inclusive of providing and fixing vibration pads and wooden pieces. Wherever specified or required by the project engineer.

Flexible connections, wherever required or specified shall be measured as part of straight length of same diameter with no additional allowance being made for providing the same.

The length of the pipe will be taken through the centerline of the pipe and all through the fittings (e.g., tees, bends, reducers, elbows, etc.) As through the fittings are also presumed to be pipe lengths.

II. **Valves and Flanges**

All the extra CI & CM flanged 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 gun metal (gate & globe) valves shall include two nos. Of flanges and two numbers 150 mm long ms nipples, with one side threaded matching one of the valves and other welded to the MS Slip-on-flange. Rate shall also include the necessary number of bolts, nuts and washers, 3 mm thick insertion gasket of required temp., grade and all items specified in the specifications.

III. **Structural Supports**
Structural supports including supports fabricated from pipe lengths for pipes shall be measured as part of pipe line and 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 DBR.

IV. Insulation

Unless otherwise specified measurement for duct and pipe insulation for the project shall be on the basis of centerline measurements described herewith.

V. Pipe Insulation

This service shall be measure be measured in units of length along the centerline 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 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 centerline of pipe.

VI. DUCT INSULATION AND ACOUSTIC LINING:

This service shall be measured on the basis of surface area along the centerline of insulation thickness. Thus the surface areas of externally thermally insulated or acoustically lined duct shall be based on the perimeter comprising centerline (of thickness of insulation) width and depth of the cross section of insulated or lined duct, multiplied by the centerline length including tapered pieces, bends, tees, branches etc. as measured for bare ducting.

38. SYSTEM TESTING ADJUSTMENT AND BALANCING

1. SCOPE

   a) Testing, adjusting and balancing of heating, ventilating and air-conditioning systems at site.
   b) Testing, adjusting and balancing of HVAC Hydronic system at site.
   c) Testing, adjusting and balancing of exhaust system at site.

   Comply with current editions of all applicable practices, codes, methods of standards prepared by technical societies and associations including:

   ASHRAE: 1999 HVAC Application

   SMACNA: Manual for the Balancing and Adjustment for air distribution System

2. PERFORMANCE

   a) Verify design conformity.
   b) Establish fluid flow rates, volumes and operating pressures.
   c) Take electrical power readings for each motor.
   d) Establish operating sound and vibration levels.
   e) Adjust and balance to design parameters
   f) Record and report results as per formats specified.

3. DEFINITIONS

   Test: To determine quantitative performance of equipments.
Adjust: To regulate for specified fluid flow rates and air patterns at terminal Equipments (e.g. reduce fan speed, throttling etc.)

Balance: To proportion within distribution system (sub mains, branches and Terminals) in accordance with design quantities.

4. TESTING, ADJUSTING AND BALANCING (TAB) PROCEDURES

The following procedures shall be directly following in TAB of the total system.

Before commencement of each one of the TAB procedure explained hereunder, the contractor shall intimate the Engineer-In-Charge about his ready to conduct the TAB procedures in the format given in these specifications.

5. DESCRIPTION OF SYSTEM AND REQUIREMENT

Adjust and balance the following system to provide most energy efficient operation compatible with selected operating conditions.

- All supply, return and outside air systems.
- All exhaust air systems
- All chilled water systems.
- All cooling tower (condenser) water systems.
- Emergency purge systems

6. AIR SYSTEMS

a) Air Handlers Performance

The TAB procedure shall establish the right selection and performance of the AHUs with the following results.

- Inlet air Dry and Wet bulb temperatures.
- Outlet air Dry and Wet bulb temperatures.
- Air leaving dew point temperature
- Sensible heat Pickup
- Latent heat Pickup
- Sensible heat factor

b) Air distribution

Both supply and return air distribution for each AHU and for areas served by the AHU shall be determined and adjusted as necessary to provide design air quantities. It shall cover balancing of air through main and branch ducts utilizing telescoping probes of Electronic Rotating Vane Anemometers and Accubalance for grilles and diffusers.

c) The Preparatory work

To conduct the above test, following preparatory works are required to be carried out including the availability of approved for construction shop drawings and submittals.

- All outside air intake return air and exhaust air dampers are in proper position.
- All system volume dampers and fire dampers are in full open position.
- All access doors are installed & are airtight.
- Grilles are installed & dampers are fully open.
Provision and accessibility of usage of TAB instruments for transverse measurements are available.

All windows, doors are in position.

Duct system is of proper construction and is equipped with turning vanes and joints are sealed.

7. **HYDRONIC SYSTEM BALANCING**

The Hydronic system shall involve the checking and balancing of all water pumps. Piping network (main & branches), the heat exchange equipments like cooling and heating coils, condensers and chillers and cooling towers in order to provide design water flows.

The essential preparation work, must be done by the HVAC contractor prior to actual testing, adjusting and balancing of HVAC system and ensure following:

a. Availability of co-ordinate drawings and approved submittals and system sketch with design water flows specified thereon.

b. Hydronic system is free of leaks, is hydrostatically tested and is thoroughly cleaned, flushed and refilled.

c. Hydronic system is vented.

d. The contractor shall confirm completion of the basic procedures and prepare checklists for readiness of system balance.

e. Check pumps operation for proper rotation and motor current drawn etc.

f. Confirm that provisions for TAB measurements (Temperature, pressure and flow measurements) have been made.

g. Open all shut-off valves and automatic control valves to provide full flow through coils. Set all balancing valves in the preset position, if these values are known. If not, shut all riser balancing valves except the one intended to be balanced first.

h. Balancing work for both Chilled Water System and Condenser Water System shall be carried out in a professional manner and test reports in the specified format shall be prepared and presented to the HITES / Engineer-In-Charge for approval.

8. **READINESS FOR COMMENCEMENT OF TAB**

Prior to commencement of any test, the readiness to do so should be recorded as per the prescribed checklist.

9. **TAB INSTRUMENTS**

i. Air measuring Instruments

For measuring DB and WB temperature, RH and dew point, microprocessor, suitable instrument shall be used. This instrument shall be capable of calculating the sensible, latent total heat flows, sensible heat factor and give printouts at site and have data logging/downloading facility.

For measuring Air velocity, DB temperature and Air volume, suitable instrument shall be used. It shall be able to provide instant print out of recorded Air Volume readings.

Pitot tube.

Electronic Rotary Vane Anemometer.

Accubalance Flow Measuring Hood.

ii. Hydronic Measuring Instruments
For measurement of water flow differential pressure and temperature, the instrument shall have a built-in microcomputer capable of giving readings for pressure differential flow rate and temperature.

iii. Rotation Measuring Instrument

- Electronic Digital Tachometer

iv. Temperature & RH Measuring Instrument

v. Electrical Measuring Devices

- Clamp on Volt ammeter
- Continuity Meter

10. **VIBRATION AND NOISE LEVELS**

Vibration and alignment field measurements shall be taken for each circulating water pump, water chilling unit, air handling unit and fan driven by a motor over 10 HP. Readings shall include shaft alignment, equipment vibration, bearing housing vibration, and other tests as directed by the Engineer-In-Charge.

Sound level readings shall be taken at ten (10) locations in the building as selected by the Engineer-In-Charge. The readings shall be taken on an Octave Band Analyzer in a manner acceptable to him. The contractor shall submit test equipment data and reporting forms for review. In order to reduce the ambient noise level the readings shall be taken at night. All tests shall be performed in the presence of HITES / Engineer-In-Charge.

**LIST OF BUREAU OF INDIAN STANDARD CODES**

<table>
<thead>
<tr>
<th>IS 1239 (Part – I) 1979</th>
<th>Mild Steel Tube</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 1239 (Part – I) 1982</td>
<td>Mild Steel Tubular and Other Wrought Steel Pipe Fittings</td>
</tr>
<tr>
<td>IS 4736 – 1986 (Reaffirmed)</td>
<td>Hot Dip Zinc Coatings of Steel Tubes</td>
</tr>
<tr>
<td>IS 823-1964</td>
<td>Code of Procedure For Manual Metal Arc Welding of Mild Steel</td>
</tr>
<tr>
<td>IS 780-1984</td>
<td>Service Valves For Water Works Purpose</td>
</tr>
<tr>
<td>IS 778-1980</td>
<td>Copper Alloy Gate, Globe and Check Valves For Water Works Purpose</td>
</tr>
<tr>
<td>IS 1536-1976</td>
<td>Flanges Configuration</td>
</tr>
<tr>
<td>IS 5312 (Part –I) 1984</td>
<td>Swing Check Type Reflux Non Return Valves For Water Works</td>
</tr>
<tr>
<td>IS 2379-1963</td>
<td>Color Code For Identification of Pipelines</td>
</tr>
<tr>
<td>IS 554-1975</td>
<td>Dimension For Pipe Thread Where Pressure Tight Joints Are Required On Threads</td>
</tr>
<tr>
<td>IS 655-1963 (Reaffirmed 1991)</td>
<td>Metal Air Ducts</td>
</tr>
<tr>
<td>IS 277-1992</td>
<td>Galvanized Steel Sheet For Fencing</td>
</tr>
<tr>
<td>IS 4064 Part II-1978</td>
<td>Specific Requirements For Direct Switches of Individual Motors</td>
</tr>
<tr>
<td>IS 3854-1969</td>
<td>Switches For Domestic &amp; Similar Purpose</td>
</tr>
<tr>
<td>IS 732 (Part III-1902)</td>
<td>Inspection and Testing of Installation</td>
</tr>
</tbody>
</table>
39. SPECIFICATIONS FOR ELECTRICAL WORKS

1. **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.

   All electric motors shall be suitable for 3 phase, 50 cycles 415 volts a.c. supply.

2. **CONTROL PANEL:**
   2.1 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.

   2.2 The panels shall be provided wherever necessary with necessary interlocks designed to prevent incorrect operation and to ensure safety of operating personnel and equipment.

   2.3 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.

3. **CONTACTER STARTERS:**
   3.1 **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 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.

3.2 **DOL Contactor Starter**

The contactor shall be air break type coil operated, DOL contactor starter, provided 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 and quick break, double break type consisting of robust silver contacts. The coil voltage shall be 440/240 volts at 50 c/s. The starter shall be provided with trip indication light and overload reset bush button for overload relay.

4. **SQUIRREL CAGE INDUCTION MOTORS:**

4.1 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 induction 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.

(a) Cooling tower & exhaust blower - IP:55(TEFC)
(c) Pumps IP:55(TEFC/SPDP).

4.2 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 HP suitable for DOL starting. The compressor motor shall be provided with automatic star delta starter.

The console shall contain on/off push buttons 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.
CHAPTER- M

TECHNICAL SPECIFICATIONS -FIRE FIGHTING SYSTEM

1. FIRE FIGHTING WORKS- FIRE PROTECTIONS-GENERAL

Scope of work shall include design, engineering, supply, installation, testing & commissioning of fire fighting system. All material shall be of conforming to relevant IS specifications wherever exists and subject to approval of Engineer in charge. The fire fighting 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 buildings.

1.1. TENDER DRAWINGS

For guidance of the bidder, drawings (Schematic Fire Fighting Layout/External Fire 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 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, Signages, Terrace layout with OHT & Terrace pump.

Plant Room Layout illustrating UG sump details, piping details, valves, pressure vessel, pressure switch, ICV, strainers, diesel tank with its piping & other accessories, foundation details, pump locations, sloping pattern inside pump room, drain/ sumps, fire panel, cable trays etc. at no extra cost for approval by the Engineer before commencing fabrication/ manufacture of the equipment. Such shop drawings shall be based on the Architectural drawings/Tender Drawings and requirements laid down in the specifications, Design Basis Report 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 co-ordinated 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 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:-

a. General Layout of Pump House including all details mentioned in clause 1.2.

b. Panels and other equipment/accessories location and their dimensions etc.

c. Fire fighting floor layout including terrace indicating internal hydrants, sprinklers complete with pipe dia., pipe spacing interval etc.

d. Complete schematic as installed.
e. UG Sumps, Location of External Hydrants, 2-way/4-way fire brigade inlet connection, Draw out connection, Earth pipes, route of earthling conductors etc.
f. Route of all cables and pipes run along with detail sizes and mode of installation.

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.

a. Warranty for required equipment installed like Pumps, Panels etc.
b. As Built Drawings
c. Material Test Certificates
d. Catalogues/Brochures
e. Operation and Maintenance Manuals
f. List of recommended spares and consumables
g. All approvals including technical approvals and sanctions
h. 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:-

a. Preparation & submission of working drawings
b. Obtaining the approval of drawings
c. Arranging inspection of site by officials of the Authority
d. Obtaining the final No objection/ completion certificate after submitting required documents.
e. 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.

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.
1.8. 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.

1.9. INSPECTION AND TESTING

a. 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.

b. 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.

c. The E-I-C may, at his sole discretion, carry out inspection at different stages during manufacturing and final testing after manufacturing.

d. 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.

1.10. TRAINING OF DEPARTMENT PERSONNEL

a. 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).

b. The period of training shall be adequate and mutually agreed upon by the Engineer and contractor.

c. The CLIENT/ HITES’s personnel shall also be trained for routine maintenance work and lubrication, overhauling, adjustments, testing, minor repairs and replacement.

d. Nothing extra shall be paid to the contractor for training CLIENT/ HITES’s personnel.

1.11. 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.

c. Any defective material or equipment supplied by the contractor.

d. 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:

a. Straight runs not exceeding 30 m on pipe lines 80 mm dia and above.

b. Both ends of any fabricated fittings e.g. bend tees etc. of 65 mm dia or larger diameter.

c. For jointing all types of valves, appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and required as per good engineering practice.

d. 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 radiographic ally 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>20mm</td>
<td>20mm</td>
<td>22mm</td>
<td>24mm</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>
<tr>
<td>No. of hole</td>
<td>4 mm</td>
<td>4 mm</td>
<td>8 mm</td>
<td>8 mm</td>
</tr>
</tbody>
</table>

2.6. **PIPE PROTECTION**

a. 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.

b. Pipes in chase or buried underground shall be painted with two coats of hot bitumen, wrapped with bituminous pykpote or Hessian cloth and finished with one coat of hot bitumen paint.

c. 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 galvanised nuts and bolts. The size/diameter of the anchor fastener and the clamp shall be suitable to carry the weight of water filled pipe and dead load normally encountered. 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 Colour. 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**
Butterfly, 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 C. 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/sqcm, 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/sqcm, 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 & toughened glass. The suitability of pressure gauge shall be in the temperature range of (-) 20 degree Celsius to 60 degree Celsius. 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/sqcm.

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/sqcm for 2.5 mins.

The flow test shall be at 7 kg/sqcm at 900 lpm. The water tightness seat test shall be at 14 kg/sqcm. 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/Sqcm. 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 approx.) 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 enamelled 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/sqcm for 2.5 mins. The flow test shall be at 7 kg/sqcm at 900 lpm. The water tightness seat test shall be at 14 kg/sqcm. 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/Sqcm. 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 colour with 36 mts 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 door with lock and key arrangement & shall be painted with one coat of primer & two coat of finished stove enamelled post office red colour 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. **ELECTRIC DRIVE, HORIZONTAL FIRE PUMPS**

Without restricting to the generality of the foregoing, the pumps and ancillary and accessories.

i. Electrically operated pumps with motors, base plates and accessories.

ii. Alarm system with all accessories wiring and connections.

iii. Pressure gauges with isolation valves and piping bleed and block valves.

iv. M.S. pipes, valves, suction strainers, delivery headers and accessories.

v. Foundations, vibration eliminator pads and foundation bolts.

3.1. **QUALITY CONTROL**

These shall comply with the IS codes as specified.

3.2. **SUBMISSIONS**

a. Product Manuals

b. Hydraulic Details

3.3. **STORAGE**

These shall be stored as delivered in original packing.

4. **FIRE, SPRINKLER AND JOCKEY PUMPS ELECTRIC DRIVE AND DIESEL ENGINE**

4.1. **PUMPING SETS**

a. All pumps (main sprinkler & hydrant pumps, jockey pumps, diesel driven pump) shall be of suitable capacity & head to meet the requirements of NBC 2016.

b. Pumping sets shall be multi stage horizontal split casing/end suction type centrifugal Pump having single outlet with cast iron body and bronze dynamically balanced impellers with mechanical seals. Connecting shaft shall be stainless steel with bronze sleeve and grease- lubricated bearings. The centrifugal pumps shall conforming to IS 1520.
c. Pumps shall be connected to the drive by means of spacer type love joy couplings, which shall be individually balanced.

d. The coupling joining the prime movers with the pump shall be provided with a sheet metal guard. Pump and motor engine shall be mounted on a common base plate fabricated from MS section.

e. Pumps shall be provided with approved type of mechanical seals.

f. Pumps shall be capable of delivering not less than 150% of the rated capacity of water at a head of not less than 65% of the rated head. The shut off head shall not exceed 120% of the rated head.

g. The pump shall meet the requirements of N.B.C. 2016 and N.F.P.A. and the unit shall be design proven in fire protection services.

4.2. ELECTRIC DRIVE

a. Electrically driven pumps shall be provided with totally enclosed fan ventilated induction motors of efficiency rating IE-3. For fire pumps the motors should be rated not to draw starting current more than 3 times normal running current.

b. Motors for fire protection pumps shall be at least equivalent to the horse power required to drive the pump at 150% of its rated discharge and shall be designed for continuous full load duty and shall be design proven in similar service.

c. Motors shall be wound for class F insulation and winding shall be vacuum impregnated with heat and moisture resistant varnish glass fiber insulated.

d. Motors for fire pumps shall meet all requirements and specifications of N.B.C.-2016 and N.F.P.A.

e. Motors shall be suitable for 415 volts, 3 phase 50 cycles A/c supply and shall be designed for 38 deg. C ambient temperature. Motors shall conform to I.S. 325.

f. Motors shall be designed for two-start system.

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

h. Contractor shall provide inbuilt heating arrangements for the motors for main pumps to ensure that motor windings shall remain dry.

i. Speed of the motors shall be compatible with the speed of the pump.

j. Suitable PCC/RCC foundation with plaster, Antivibration arrangement of cushy foot mounting for all pumps needs to be provided.

4.3. PRESSURE VESSEL

a. Air vessel shall be fabricated from 10 mm M.S. plate with dished ends and suitable supporting legs. Air vessel shall be provided with a 100 mm dia flanged connection from pump, one 25 mm dia. drain with valve, one gunmetal water level gauge and 15 mm sockets for pressure switches. The vessel shall be 450 mm dia x 2000 mm high In Plant Room & 250 mm dia. & 2000 mm high at Terrace or as per requirement and tested to 20 kg/ sq. cm pressure. One pressure vessel for Hydrant system & one for sprinkler system to be provided.

b. The fire pumps shall operate on drop of pressure in the mains. The pump operating sequence shall be arranged in a manner to start the pump automatically but should be stopped manually by starter push buttons only for Electric Pumps.

4.4. VIBRATION ELIMINATORS
All individual suction and delivery lines shall be with double flanged reinforced neoprene flexible pipe connectors (double arch of min. PN 16 rating). 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 connector shall be as per manufacturer's details.

It shall be resilient rubber lined single arch vibration eliminators suitable for raw water up from (-) 10 deg. C to 150 degree celsius temperature, working pressure 8.8 Kg/cm² (approx.) and test pressure 24 bar (approx.). It shall be preferably without gaskets & it should compensate for any misalignment/offset.

4.5. INSTALLATION

a. Pumps shall be installed true to level on suitable concrete foundations. Base plate shall be firmly fixed by foundation bolts properly grouted in the concrete foundations. Angle iron frame of size 35mmx35mmx3mm shall be provided on the edge of foundation.

b. Pumps and motors shall be truly aligned by suitable instruments.

c. All pumps connections shall be standard flanged type with appropriate number of bolts. In case of non-standard flanges companion flanges shall be provided with the pumps.

d. Manufacturer’s instructions regarding installation, connections and commissioning shall be followed with respect to all pumps and accessories.

e. Contractor shall provide necessary test certificates and performance charts with NPSH requirement of the pumps from the manufacturer. The contractor shall provide facilities to the Engineer-in-charge or their authorized representative for inspection of equipment during manufacturing and also to witness various tests at the manufacturer’s works without any cost to the HITES.

f. Each pump shall be provided with a 150 mm dia pressure gauge, isolation cock and connecting piping, bleed and block valve.

g. Provide vibration eliminating pad and connectors for each pump.

h. A minimum clearance of 1M around the pumps shall be provided.

4.6. DIESEL ENGINE

a. Diesel engine shall be of multi cylinders (4/6 cylinder AS PER REQUIREMENTS) with individual head assemblies. The engine shall be water-cooled and shall include heat exchanger/radiator cooled and connecting piping, strainer, isolating and pressure reducing valves, bye-pass line complete in all respects.

b. Engineer shall be direct injection type with low noise and exhaust emission levels and shall conform to BS649/IS 1601/IS10002 as amended up to date.

c. The speed of the engine shall match the pump speed for direct drive.

d. The engine shall be capable of being started without the use of wicks, cartridge heater, plugs or either at engine room temperature of 7 deg. C and shall take full load within 15 seconds from the receipt of the signal to start.

e. The Engine shall efficiently operate at 38 deg. C ambient temperature at 50 m above mean sea level.

f. Noise level of the engine shall not exceed 105 DBA (free field sound pressure) at 3 m distance.
g. The engine shall be self starting type up to 4 deg. C and shall be provided with one 24 V heavy duty DC battery, starter, cut-out, battery leads complete in all respects. One additional spare battery shall be provided. The battery shall have a capacity of 180 to 200 ampere hours and 640 amps cold cranking amperage.

h. A battery recharger of 10 to 15 amperes capacity with trickle and booster charging facility and regulator shall be provided.

i. Annunciation panel shall be suitable for working on 24 volts D.C. Arrangement for starting shall be automatic on receiving the signal but shutting off shall be manual.

j. The engine shall be provided with an oil bath or dry type air cleaner as per manufacturer’s design.

k. Engine shall be suitable for running on high speed diesel oil.

l. The system shall be provided with a control panel with push button starting arrangement also and wired to operate the engine on a differential pressure gauge.

m. The entire system shall be mounted on a common structural base plate with ant vibration mountings and flexible connections on the suction and delivery piping.

n. One fully mounted and supported day oil tank fabricated from 5mm thick M.S. sheet electrically welded shall be provided alongwith level indicating gauge glass on the day oil tank and low fuel indication of the control panel. The capacity of tank should be sufficient to allow engine to run on full load for at least 2 hours. The fuel pipe from diesel tank to pump should be of robust construction, preferably of hard rubber.

o. Exhaust pipe shall be provided with suitable muffler (residential type) to discharge the engine gases to outside open air as per site conditions. The piping shall be duly insulated with 50mm thick glass wool/rockwool of suitable density & K value and 1.0mm thick aluminium sheet cladding.

p. All accessories fittings and fixtures necessary and required for a complete operating engine set shall be provided.

4.7 OPERATING CONDITIONS FOR JOCKEY, ELECTRIC & DIESEL PUMPS

a. Jockey pump shall start automatically when the Water Pressure in the System falls to a pre-set value and shut down when the system pressure reaches the set value. Both Limits shall be adjustable. The Pressure switch settings for Jockey Pump shall be determined as per relevant codes and Site Conditions.

b. Main Electric Fire Pump shall operate on account of sudden pressure loss. So, long as Main Electric Fire Pump is working, other Fire Pumps will not operate. The Pump shall start when the water pressure falls to a pre-set value in the system The Pressure switch settings for Jockey Pump shall be determined as per relevant codes and Site Conditions.

c. The Diesel Fire Pump will start on sudden pressure loss, only in case supply to main electric Fire Pump is not available or within a pre-set time the main Electric Fire Pump fails to start or fails during operation. No other pump will be working when Diesel Engine fire Pump is in operation. Audio-Visual Alarm shall be available to indicate failure of Main Electric Fire Pump.

d. A three attempts starting facility will be provided for diesel Pump.

e. If within a pre-set time, the pump also fails to start or fails to develop pressure, the diesel pump shall also be shut down and locked out. An audio visual alarm indication shall be given at the Control Panel.
f. The Terrace Pump will start on sudden pressure loss of pressure only when both the Fire Pumps have either failed to start or exhausted water.

g. Only one pump will be working at a time. In manual mode, more than one Pump can be started.

h. Water Level in UG and Terrace Tanks shall be monitored and in case of low water level, pumps connected with the tank shall not operate (even on manual mode) or stop operation as the case may be. An audio-visual alarm shall be given at the Control Panel. The Terrace Fire Tank shall be provided with Baffles to ensure proper circulation of water before overflow/discharge into domestic tank.

5. **ELECTRICAL INSTALLATIONS**

5.1. **POWER AND CONTROL PANEL AND OTHER CONTROL COMPONENTS**

For Fire Fighting Panel & Control Panel, specifications under Technical Specifications for LT Panel under Electrification shall be followed. Power /Control cable of various sizes shall be XLPE insulated & PVC sheathed.

5.2. **CABLE LAYING:**

Cable shall be laid generally in accordance with CPWD Specifications (Electrical) External & Internal amended upto date. Cables shall be laid on 14 gauge perforated MS sheet cable trays and cable drops/risers shall be fixed to ladder type cable trays fabricated out of steel angle. Access to all cables shall be provided to allow cable withdrawal/ replacement in the future. Where more than one cable is running, proper spacing shall be provided to minimize the loss in current carrying capacity. Cables shall be suitably supported with Galvanized saddles when run on walls/trays. When buried, they shall be laid in 350 mm wide and 750 mm deep trench and shall be covered with 250 mm thick layer of soft sifited sand & protected with bricks, tiles. Special care shall be taken to ensure that the cables are not damaged at bends. The radius of bend of the cables when installed shall not be less than 12 times the diameter of cable 1.1 KV cable shall be buried 600 mm below ground level. For additional details pertaining to Cable Laying, Refer the Electrical Works Specifications under the relevant Head.

5.3. **WIRE SIZES:**

For all Single phase/ Three phase wiring, 1100 volts grade PVC insulated copper conductor wires shall be used. The equipment inside plant room and AHU room shall be connected to the control panel by means of insulated aluminum conductor wires of adequate size. An isolator shall be provided near each motor/equipment wherever the motor/equipment is separated from the supply panel through a partition barrier or through ceiling construction. PVC insulated single strand aluminum conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads shall be provided at both the ends for easy identification in control wiring.

The minimum size of control wiring shall be IS marked 2C/5C x 1.5 mm² PVC insulated stranded soft drawn copper conductor wires drawn through conduit to be provided for connecting equipment and control panels.

Power wiring cabling shall be of the following sizes:

i. Upto 5 HP motors

   Functional requirement

   :- 3.5C x 6 mm² Al conductor wires or meeting functional requirement

ii. Above 5HP upto to 15 HP motors

   Meeting functional requirement

   :- 1 No. 3.5C x 10 mm² Al conductor wires or meeting functional requirement
iii. From 20 HP to 25 HP motors: 2 Nos. 3.5C x 25 mm² Al conductor armoured cables or meeting functional requirement

iv. From 60 HP to 75 HP motors: 2 Nos. 3.5C x 50 mm² Al conductor armoured cables or meeting functional requirement

v. 100 HP motors: 2 No. 3.5C x 100 mm² Al conductor armoured cables or meeting functional requirement.

All the switches, contactors, push button stations, indicating lamps shall be distinctly marked with a small description of the service installed. The following capacity contactors and overload relays shall be provided for different capacity motors.

The motor starter shall conform to IS 1822 as amended upto date.

5.4. EARTHING:

For Earthing details, Refer the CPWD Electrical Works Specifications 2013 and electrical specification.

5.5. DRAWINGS:

Shop drawings for control panels and wiring of equipment showing the route of conduit/cable shall be submitted by the contractor for approval of Engineer-in-Charge before starting the fabrication of panel and starting the work. On completion, four sets of complete "As-installed" drawings incorporating all details like, conduits routes, number of wires in conduit, location of panels, switches, junction/pull boxes and cables route etc. shall be furnished by the Contractor.

5.6. TESTING:

Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with relevant BIS Codes and test report furnished by a qualified and authorized person. The entire electrical installation shall be got approved by Electrical Inspector and a certificate from Electrical Inspector shall be submitted. All tests shall be carried out in the presence of Supervisor.

5.7. PAINTING:

All sheet steel work shall undergo a process of degreasing, thorough cleaning, and painting with a high corrosion resistant primer. All panels shall then be backed in an oven. The finishing treatment shall be by application of synthetic enamel paint of approved shade.

5.8. LABEL AND TAGS

Engraved PVC labels shall be provided on all incoming and outgoing feeders switches. Circuit diagram showing the arrangements of the circuit inside the control panel shall be pasted on inside of the panel and covered with transparent plastic sheet. All cables terminations at panels and at equipments shall be provided with tags as approved by Project Manager.

1. All panels to have provision for padlocking and all MCCB’s/ MCB’s to have provision for locking in off position.

5.9. ELECTRIC FIRE PUMP PANEL:

The main switch board shall be floor mounted/ wall mounted fabricated from 2mm thick CRCA sheet powder coated with IP 42 protection

3Ph 415V Normal supply for fire pumps near UG tank and Essential supply for terrace pump and jockey pumps

The panel shall incorporate the following facilities.
a. TP &N Moulded case circuit breaker of appropriate fault level

b. Control system components and equipment such as relays, contractors, and timers etc. for automatic operation.

c. Starter unit, current transformer and ammeter

d. Indication lamps, their fuses, terminal block, push button, control and selector switches etc. as required.

e. Pump lock out devices due to faults or abnormalities as specified.

f. Visual/ audio alarms, indications and communications facility as specified.

g. Necessary inter-connection control and power cable work, cable glands, lungs and internal wiring and connections.

5.10. ENGINE SECTION: -

The engine section shall incorporate the following facilities.

a. Control system components and equipment such as relays, contractors, and timers etc. for automatic operation.

b. Instruments, indicator lamps, fuses, terminal blocks, push buttons, control and selector switches etc. as are required.

c. Engine shut down and block out devices due to faults or abnormalities as specified.

d. Visual/ audio alarm indication and enunciator facility as specified.

e. Inter-connection control and power cable work, cable glands, lungs, all internal wiring and connection etc.

5.11. AUXILIARY PUMP SECTION: -

Each of the auxiliary pump section for priming pump shall incorporate the following:

a. TP&N Moulded case circuit breaker

b. Control system components such as relays, timers, contractors etc. as are necessary for functional requirements.

c. Starter unit, current transformer and ammeter

d. Indication lamps, fuses, terminal blocks, push buttons selector, switch etc. as required.

e. Inter-connections, power and control cable work, cable plants lugs, internal wiring and connections.

f. Low water level alarm for terrace tank, where provided.

5.12. SYSTEM CONTROLLER : -

The system controller shall consist of relay timer, contactor etc for interlocking of fire pump and fault isolation and incorporate the following:

a. Control components integrating the various sections, so as to satisfy the functional requirements.

b. Battery charger unit with boost/ float charge facility with voltmeter, capable of independently charging 1 set of battery at a time.

c. Visual/ audio alarms not covered in individual sections.

d. Lamps healthy test facility.

e. Instruments, indicating lamps, push buttons, fuse terminal blocks etc. as are required.
f. Test facility to stimulate operation of hydrants.

5.13. OTHER CONTROL COMPONENTS

5.13.1. Pressure Switches:

Pressure switches shall be provided for switching on and off the jockey pump at present pressures and also for switching of the fire pump at priest pressure. Being the main component for initiating the signal for the operation of the pumps, the pressure switches shall be totally reliable, sturdy in construction and of long life. The pressure settings shall be adjustable.

5.13.2. Low water level indication and switch:

To prevent the dry running of the fire pumps due emptying of the static tank, water level indication and switch shall be provided. This shall trip the electric motor or stop the diesel engine, as the case may be when the water level goes below a present level. This shall also furnish a distinct low water level audiovisual alarm. This should indicate the level of water at different stages is the power and control panel.

5.13.3. Power Supply for Controls:

In order ensure that the control systems remains operational at all times, the control system shall be designed for 24V DC operation, fed from 24 V wet battery. This shall be independent of the starting battery for the engine i.e., battery shall remain trickle charged at the times from the common battery, charges at the control section.

6. GAS BASED FIRE SUPPRESSION SYSTEM:

6.1. For Low Voltage equipment /Laboratories,& other Critical Areas:

The Total Room Flooding system of fire detection and quenching is proposed in all Low Voltage Equipment rooms where Water sprinklers cannot be used. The Gas cylinder assembly should be UL/FM approved with seamless CCOE approved cylinder and will be connected to discharge nozzles through metal Piping. The master cylinder Kit fitted on Gas cylinder will be operated through separate Fire detection Panel and will release zero Ozone depletion potential Gas through the nozzles in case of fire.

6.2. For Electrical panels:

Tube based Fire protection system is used in the Electrical Panels to be installed in substations. UL listed fire detection Tube shall be installed throughout the compartment of panels. The location and spacing of tube shall be above the hazard to be protected. Cylinder equipped with brass valve, pressure Gauge isolation valve will be fitted on the wall of the panel with suitable brackets and will be connected to the detection tube. In case of fire the tube shall rupture at a point. The rupture Tube shall result in formation of discharge point and release Gas Agent in Uniform pattern.

7. PORTABLE FIRE EXTINGUISHERS:

ABC Powder stored pressure type Fire Extinguishers of 6 KG capacity IS : 15683 & CO2 gas based Fire Extinguisher of 4.5 Kg capacity with 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 celcius to 55 degree celcius. 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/sqcm & the charge test pressure shall be 15 kg/sqcm & 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/sqcm & 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.

8. **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 Photoluminescent U1000 aluminium 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.

9. **CLEAN AGENT FIRE EXTINGUISHERS**

Clean Agent Fire Extinguishers are proposed to be provided in areas proposed in DBR 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 of 4 kg (minimum) capacity with Discharge time: 8 Secs (approx.) & Range: 2 Meters (approx.)

10. INSTALLATION, TESTING AND COMMISSIONING

10.1. 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.

i. Cement concrete (1:2:4 Mix) foundation for all pump sets. Iron Angle framing around the Pump foundation (at the edges/periiphery) to protect it from chipping/damage etc.

ii. Vibration isolation arrangement for all pump sets

iii. Filling up the hole in flooring with cement concrete, after laying the wet riser pipes

iv. Necessary supports and clamps for wet riser pump room

v. Necessary supports and camps for wet riser plumbing in the building

vi. Supporting bracket/ frame work for the fuel oil tank of the Diesel engine.

vii. Excavation of the earth, consolidation and refilling after laying of wet riser piping in ground.

viii. Provision of necessary brick base or intermediate support as required in approved manner in case of soils which are no strong enough to support the pipes, thereby likely to cause different settlement.

ix. 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.

x. Necessary masonry work/ steel work for supporting hose cabinets near external (yard) hydrants.

xi. Valve chambers of approved design with external (yard) hydrant.

xii. Ground level hydrants of approved design, where specifies.

xiii. Cutting and making good the damages for the installation work of the riser system.
xiv. All the required control piping, exhaust piping from engine to outside, oil piping for fuel oil and lubricating oil for the engine, drain piping from the pumps to the drain point in the pump room, overflow piping from priming tank to the sump. The piping work shall include all necessary fittings, valve and accessories for effective functional requirements.

xv. Inter-connecting cable work with controls, control panel, batteries etc. including battery leads.

xvi. 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 1.5m 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 75sqcm 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.

10.2. 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.

10.3. 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 by-laws.

10.4. PIPE WORK ASSOCIATED WITH DIESEL ENGINE

a. Pipe works for fuel system, lube oil system and exhaust system shall be complete with all required supports, clamps, hangers etc. for a complete work.

b. Fuel feed is by gravity and the fuel tank shall be located at least 60cm above the fuel injection pump.

c. Fuel pipe of copper shall not be soldered but brazed or welded.

d. No valves or cocks shall be provided in the fuel feed line to engine from the fuel tank.

e. Precautions shall be taken to prevent any air locks in any part of the fuel system. No air relief cock shall be permitted and where inescapable, screwed plugs shall be provided for the purpose.
f. The installation of the fuel supply system shall be such that a completely primed condition is maintained, free from air lock.

g. Filters shall be provided in fuel oil and lube oil circuits allocations that are easily accessible for maintenance.

11. TECHNICAL SPECIFICATIONS FOR SPRINKLER SYSTEM

All the piping for sprinkler work shall be with MS Class C & shall conform to IS 1239/3589.

11.1. SPRINKLER HEADS

a. 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 celcius (red colour), 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.

b. 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.

c. Side Wall Sprinklers

i. 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.

d. Constructions

i. 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.

ii. 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 shall be stable and shall withstand pressure surges or external vibration without displacement.

iii. 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.

iv. Deflector: - The deflector shall be suitable for either upright or pendant erection. The deflector shall be designed to give an even distribution of water over the area protected by each sprinkler.
e. Colour 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>

d. Size of Sprinklers Orifices

The following sizes of sprinklers shall be selected for various classes or hazards.

- **Moderate hazard**: 15 mm nominal bore

f. 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

h. 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.

i. Maximum & Minimum Distance between sprinklers, between sprinklers & boundary wall shall be as per hazard classification of building & relevant IS codes.

j. 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 required buildings as specified in DBR (Design Basis Report) where sprinkler provision is to be considered shall be with min. one independent ICV.

k. In order to avoid any kind of leakage from sprinklers, it shall be wound with Teflon tape & any other suitable water resistant sealing material.

l. All measures to be considered so that sprinkler bulb is cleaned & free from any blemishes.

m. Sprinkler type (pendant/upright/sidewall) shall be conforming to requirements & relevant IS codes.

### 11.2. PIPES AND FITTINGS

a. Pipes

i. Pipes less than 25mm dia shall not be used and shall be Black Steel conforming to IS: 1239 (Heavy Class) upto 150mm.

ii. Welded Black Steel Pipe, Heavy Class conforming to IS:3589 for size greater than 150mm.

iii. 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**
   i. 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.
   ii. 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**
   50 m dia black steel pipe conforming to IS: 1239 heavy class with 50 mm gunmetal full way valve for draining water in the system in low pockets.

11.3. **INSTALLATION CONTROL VALVE:-**

Installation control valves shall comprise of the following.
   a. One main stop valve of full way pattern with gunmetal pointer to indicate where open/ shut
   b. One automatic alarm valve, fitted with handle and cover.
   c. One hydraulic alarm motor and gong for sounding a continuous alarm upon out-break of fire.
   d. One combined waste and testing valve including 5 mtr of tubing and fittings
   e. Alarm stop valve
   f. Strainer
   g. Drain plug
   h. Padlock & strap
   i. Wall box for installation of valve
11.4. 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.

9.5 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.
   A.C. Power Supply
   Fault and Fire indication lamp
   Alarm acknowledgment push buttons
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.

9.6 BATTERY UNIT

i. The system shall be powered by lead acid storage stationery complete with automatic duel rate charger boost and trick operating form 220 V, 50 Hz, single phase, mains supply. The battery capacity should be adequate for operation of the system connected to it for at least 24 hours in the non-alarm state followed by 30 minutes operation of all sounders and other connected equipments after a power (mains) failure.
ii. The automatic charger should operate at the boost charge when the battery terminal voltage is less than about 2.1 V 20 per cell, and operate at a trickle charge rate of 100 to 200 AH, when the battery terminal voltage exceeded about 2.25 per cell.

iii. The power unit should have the following.
   a. Voltmeter of suitable range
   b. Ammeter of suitable range
   c. Indicator lights for mains
   d. Indicator lights for DC output

iv. The preferred nominal DC voltage shall be 24 V and shall preferably be isolated. (If and isolated supply is provided a line earthing indicator should also be provided).

v. The DC system and the detection and sounder circuits shall be protected against their attaining a voltage to earth exceeding 50V.

vi. The connection to the 230 V, 50 Hz, single phase system shall be through a three pin plug socket especially provided for the connection to the annunciation panel. This connection should in addition utilized for earthing all non-current carrying metal parts of the sprinkler system, except those that are either doubly insulated or mounted at a height exceeding 2.2 meters.

vii. The battery unit shall be housed in a steel cabinet at least 2 mm thick suitably painted with two coats of Post Office Red, Enamel necessary vent holes should be provided for proper ventilation.

12. 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. One pressure gauge on delivery side of each pump
   d. One Pressure Gauge, part of Pressure vessel installation.
   e. On the Common Delivery Header of Fire Pumps, one on either side of the Non Return Valve.
   f. On the Wet Riser in every Fire Hose Cabinet Shaft.
   g. Any other location as per requirement.

13. INSTALLATION OF PIPING

A. BELOW GROUND PIPING:

Under ground 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.

b. Piping shall be screwed type up to 50 mm dia. Welding of joints will be allowed for pipes of 65mm mm of larger diameters.

14. 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/ equipments 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/sqcm. The drop of pressure upto 0.5 kg/sqcm shall be accepted.

After completion, all operation checks (operation scheme of pumps & pressure switch settings) needs to be carried out for automatic operation of the system. landing valves may be opened at different locations repeated couple of times to ensure trouble free operation.

Flow Test -The design flow of pumps shall be checked. The pump shall be operated after opening a number of Landing Valves at different locations. Design pressure is to be maintained in the Pump House. Water discharge is to be measured by drop in level in UG Tank for a certain period. All pumps shall be tested one by one. The flow rate shall not be less than as specified while maintaining the design pressure in pump house.

12.2 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.

**13. 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 - N

TECHNICAL SPECIFICATIONS - BUILDING MANAGEMENT SYSTEM (BMS)

1. GENERAL

1.1. SYSTEM DESCRIPTION

A. The entire Building Management System (BMS) shall be comprised of a network of interoperable, stand-alone digital controllers communicating via BACNET/ModBus/Profibus/LonMark/Lon Talk communication protocols to a Network Area Controller (NAC) / Router.

B. The entire Integrated Control and Monitor Management System (IBMS) shall be comprise of a network of interoperable, stand-alone digital controllers communicating on an open protocol communication network to a host computer within the facility (when specified) and communicating via the Internet to a host computer in a remote location. The IBMS shall communicate to third party systems such as Chillers, Boilers, Air-Handling Systems, Energy metering systems, Lighting Management System & other energy management systems, Fire-Life safety systems and other building management related devices with open, interoperable communication capabilities.

C. The IBMS framework shall utilize JAVA/dotnet based automation products and services with built-in Internet connectivity to a broad range of distribution partners in the building automation, energy services, power/utility, and industrial sectors. The Framework shall bring together the computerization of control applications under the umbrella of single integrated system architecture. The suite of component software applications shall support true plug-and-play, multi-vendor interoperability, resulting in lower automation and information infrastructure costs. The Network Area Controllers (NAC's) shall run a JAVA Virtual Machine (JVM) platform and use a common set of tools for accessing and integrating multiple protocols.

D. The Building Management System (BMS) shall be comprised of Network Area Controller or Controllers (NAC) / Routers. The NAC / Router shall connect to the local or wide area network, depending on configuration. Access to the system, either locally in each building, or remotely from a central site or sites, shall be accomplished through standard Web browsers, via the Internet and/or local area network. Each NAC shall communicate to LonMark/LonTalk and/or BACnet/Modbus/Ethernet Direct Digital Controllers (DDC) and other open protocol systems/devices.

E. The following software packages shall be loaded into the system as minimum standard:
   a. Complete system operational software
   b. Site specific data manipulation software
   c. Active graphics software
   d. Energy management system software
   e. Alarm indication software
   g. Data Visualization Package
   h. Internet Enabled Remote Monitoring Package.

1.2. SUBMITTAL

A. Eight copies of shop drawings of the components and devices for the entire control system shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers catalog data sheets and installation instructions for all controllers, valves,
dampers, sensors, routers, etc. Shop drawings shall also contain complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings. A complete written Sequence of Operation shall also be included with the submittal package. BMS contractors supplying products and systems, as part of their packages shall provide catalog data sheets, wiring diagrams and point lists to other contractors for proper coordination of work.

B. Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media and protocol. BMS contractors shall provide these diagrams for their portions of work; the Systems Integrator shall be responsible for integrating those diagrams into the overall trunk cable schematic diagrams for the entire Wide Area Network (WAN).

C. Submittal shall also include a complete point list of all points to be connected to the BMS.

D. Upon completion of the work, provide a complete set of ‘as-built’ drawings and application software on compact disk. Drawings shall be provided as AutoCAD™ compatible files. Eight copies of the ‘as-built’ drawings shall be provided in addition to the documents on compact disk. BMS contractors shall provide as-built for their portions of work. The BMS contractor shall be responsible for as-built pertaining to overall BMS architecture and network diagrams. All as-built drawings shall also be installed into the BMS server in a dedicated directory.

2. **Operator Workstation Requirements:**

   i. **General**

   - The operator workstation portion of the BAS shall consist of one or more full-powered configuration and programming workstations, and one or more web-based operator workstations. For this project provide a minimum of 10 concurrent operator users and/or 2 concurrent engineering users within the Software.

   - The programming and configuration workstation software shall allow any user with adequate permission to create and/or modify any or all parts of the NSC and/or Software database.

   - All configuration workstations shall be personal computers operating under the Microsoft Windows operating system. The application software shall be capable of communication to all Network Server Controllers and shall feature high-resolution color graphics, alarming, trend charting. It shall be user configurable for all data collection and data presentation functions.

   - A minimum of 1 Workstation shall be allowed on the Ethernet network. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other workstations since the changes are accomplished to the databases within the NSC. Systems with a central database will not be acceptable.

   ii. **Administration/Programming Workstation & Software Requirements**

      a) The Software shall consist of the following:

         - Processor : Minimum 2.0 GHz
         - Memory : Minimum 4GB
         - Operating systems: Microsoft Windows 2008 R2 64-bit
b) The workstation shall consist of the following:

- Processor: 2.0 GHz or higher
- Memory: Minimum: 32 GB
- Operating systems: Microsoft Windows 2008 R2 64-bit
- Serial port, parallel port, USB port
- 100MBPS Ethernet NIC
- 20 GB hard disk
- DVD drive
- High resolution (minimum 1280 x 1024), 32" or higher flat panel display
- Optical mouse and full function keyboard
- Audio sound card and speakers
- License agreement for all applicable software.

iii. Web-Based Operator PC Requirements

a) Any user on the network can access the system, using the following software:

- Windows 2000/XP and above
- Internet Explorer 8 (32-bit)
- Internet Explorer 9 (32-bit)
- Firefox 4.0 (32-bit) and above
- Java-enabled

iv. General Administration and Programming Workstation Software

a) System architecture shall be truly client server in that the Workstation shall operate as the client while the NSCs shall operate as the servers. The client is responsible for the data presentation and validation of inputs while the server is responsible for data gathering and delivery.

b) The workstation functions shall include monitoring and programming of all DDC controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.

c) Programming of SDCUs shall be capable of being done either off-line or on-line from any operator workstation. All information will be available in graphic or text displays stored at the NSC. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.

v. User Interface:
a) The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any workstation. Additionally, it shall be possible to create customized workspaces that can be assigned to user groups. This interface shall support the creation of “hot-spots” that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user’s “PC Desktop” – with all the links that a user needs to run other applications. This, along with the Windows user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software, but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.

b) System shall be able to automatically switch between displayed metric vs. imperial units based on the workstation/webstations localization.

c) The BMS workstation/webstations shall be capable of multiple language display, including English, Spanish, German, French, Japanese, Finnish, Swedish, and traditional and simplified Chinese.

d) Servers and clients shall have the ability to be located in different time zones, which are then synchronized via the NTP server.

vi. User Security

a) The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by, a system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system must allow a minimum of 256 users to be configured per workstation. Additionally, the software shall enable the ability to add/remove users based upon Microsoft Windows Security Domains that enable the Client IT department to assist in user access.

vii. Configuration Interface

a) The workstation software shall use a familiar Windows Explorer-like-style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a “network map” of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions.

b) The configuration interface shall also include support for user defined object types. These object types shall be used as building blocks for the creation of the BAS database. They shall be created form the base object types within the system input, output, string variables, setpoints, etc., alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of user defined object types shall be able to be set up as a predefined aggregate of subsystems and systems. The configuration interface shall support copying/pasting and exporting/importing portions of the database for additional efficiency. The system shall also maintain a link to all “child” objects created. If a user wishes to make a
change to a parent object, the software shall ask the user if he/she wants to update all of the child objects with the change.

**viii. Color Graphic Displays**

a) The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.

b) Requirements of the color graphic subsystem include:

- At a minimum, the user shall have the ability to import .gif, .png, .bmp, .jpeg, .tif, and CAD generated picture files as background displays, and layering shall be possible.
- It shall be possible for the user to use JavaScript to customize the behavior of each graphic.
- The editor shall use Scalable Vector Graphics (SVG) technology.
- A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, ad graphs which can be “dropped” on a graphic through the use of a software configuration “wizard”. These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels.
- Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.
- Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.
- Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.
- It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries.
- Graphics should rescale based on whatever monitor or viewing device is being used.
- Be able to create graphics on varying layers the can be moved and repeated.
- Be able to create graphics within varying window panes that can be moved and/or re-referenced. For example, creating the graphical menu within a pane and referencing it on every graphics page, therefore not rebuilding thus allowing for a single spot for updates that get pushed to all the pages that reference it.

c) Additionally, the Graphics Editor portion of the Engineering Software shall provide the following capabilities:

- Create and save pages.
- Group and ungroup symbols.
- Modify an existing symbol.
- Modify an existing graphic page.
- Rotate and mirror a symbol.
- Place a symbol on a page.
- Place analog dynamic data in decimal format on a page.
- Place binary dynamic data using state descriptors on a page.
- Create motion through the use of animated .gif files or JavaScript.
- Place test mode indication on a page.
- Place manual mode indication on a page.
- Place links using a fixed symbol or flyover on a page.
- Links to other graphics.
- Links to web sites.
- Links to notes.
- Links to time schedules.
- Links to any .exe file on the operator work station.
- Links to .doc files.
- Assign a background color.
- Assign a foreground color.
- Place alarm indicators on a page.
- Change symbol/text/value color as a function of an analog variable.
- Change a symbol/text/value color as a function of a binary state.
- Change symbol/text/value as a function of a binary state.
- All symbols used by Manufacturer in the creation of graphic pages shall be saved to a library file for use by the owner.

ix. **Automatic monitoring**

a) The software shall allow for the automatic collection of data and reporting from any controller or NSC. The frequency of data collection shall be user-configurable.

x. **Alarm Management**

a) The software shall be capable of accepting alarms directly from NSCs or controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.

b) Alarm management features shall include:
• A minimum of 1000 alarm notification levels. Each notification level will establish a unique set of parameters for controlling alarm display, distribution, acknowledgment, keyboard annunciation, and record keeping.

• Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of alarm, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement).

• Playing an audible sound on alarm initiation or return to normal.

• Sending an email or alphanumeric pager to anyone listed in a workstation’s email account address list on either the initial occurrence of an alarm and/or if the alarm is repeated because an operator has not acknowledged the alarm within a user-configurable timeframe. The ability to utilize email and alphanumeric paging of alarms shall be a standard feature of the software integrated with the operating system’s mail application interface (MAPI). No special software interfaces shall be required and no email client software must be running in order for email to be distributed.

• Individual alarms shall be able to be re-routed to a user at user-specified times and dates. For example, a critical high temp alarm can be configured to be routed to a Facilities Dept. workstation during normal working hours (7am-6pm, Mon-Fri) and to a Central Alarming workstation at all other times.

• It shall be possible to re-route an alarm if a user-defined response time has been exceeded. For example, if a critical alarm has an acknowledgment time of 5 minutes and that acknowledgement does not occur, the alarm can be re-routed to a secondary receiver.

• An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes.

• The font type and color, and background color for each alarm notification level as seen in the active alarm viewer shall be customizable to allow easy identification of certain alarm types or alarm states.

• The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.

• The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of causes for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.

• The active alarm viewer can be configured such that an operator must confirm that all of the steps in a check list have been accomplished prior to acknowledging the alarm.

• An operator shall have the capability to assign an alarm to another user of the system. Such assignments shall be tracked to insure alarm response.

xi. Report Generation

a) The Reports Server shall be able to process large amounts of data and produce meaningful reports to facilitate analysis and optimization of each installation.
b) Reports shall be possible to generate and view from the operator Workstation, and/or Webstation, and/or directly from a reports-only web interface.

c) A library of predefined automatically generated reports that prompt users for input prior to generation shall be available. The properties and configurations made to these reports shall be possible to save as Dashboard reports, so that the configurations are saved for future used.

d) It shall be possible to create reports standard tools, such as Microsoft Report Builder 2.0 or Visual Studio, shall be used for customized reports.

e) Additional reports or sets of reports shall be downloadable, transferrable, and importable.

f) All reports shall be able to be set up to automatically run or be generated on demand.

g) Each report shall be capable of being automatically emailed to a recipient in Microsoft Word, Excel, and/or Adobe .pdf format.

h) Reports can be of any length and contain any point attributes from any controller on the network.

i) Image management functionality shall be possible to enable the system administrators to easily upload new logos or images to the system.

j) It shall be possible to run other executable programs whenever a report is initiated.

k) Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.

l) Minimum supplied reports shall include:
   - Activities Per Server Report
   - Activities Per User Report
   - Alarm Amount by Category Report
   - Alarm Amount by Type Report
   - Alarms Per Sever Report
   - Current Alarm Report
   - Most Active Alarm Report
   - System Errors Per Server Report
   - Top Activities Report
   - Top Alarms Report
   - Top System Errors Report
   - Trend Log Comparison Report
   - User Logins Report
   - Users and Groups Reports

m) Minimum Energy Reports shall include:
   - Energy Monitoring Calendar Consumption Report: Shall provide an interactive report that shows the energy usage on one or multiple selected days.
• Energy Monitoring Consumption Breakdown Report: Shall provide a report on energy consumption broken down using sub-metering.

• Energy Monitoring Consumption Report: Shall show the energy consumption against a specified target value.

d) Reports Server Hardware Requirements
   a. Processor
      a) Minimum: 2.0 GHz
      b) Recommended: 2.0 GHz or higher
   b. Memory
      a) Minimum: 6 GB
      b) Recommended: 8GB or higher
   c. Hard Disk: 500 GB

15. Reports Server Software Requirements
   a. Operating System: Microsoft Windows Server 2008 R2 (64-bit)
   b. SQL Versions:
      a) Microsoft SQL Server 2008 R2 Express with Advanced Services (64-bit)
      b) Microsoft SQL Server 2008 R2 Standard (64-bit)

xii. Scheduling
   a) From the workstation or webstation, it shall be possible to configure and download schedules for any of the controllers on the network.
   b) Time of day schedules shall be in a calendar style and viewable in both a graphical and tabular view.
   c) Schedules shall be programmable for a minimum of one year in advance.
   d) To change the schedule for a particular day, a user shall simply select the day and make the desired modifications.
   e) Additionally, from the operator webstations, each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.
   f) Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.
   g) It shall be possible to assign a lead schedule such that shadow/local schedules are updated based upon changes in the Lead.
   h) It shall be possible to assign a list(s) of exception event days, dates, date ranges to a schedule.
   i) It shall be possible to view combined views showing the calendar and all prioritized exemptions on one screen.
   j) It should accommodate a minimum of 16 priority levels.
Values should be able to be controlled directly from a schedule, without the need for special program logic.

**Programmer's Environment**

a) Programming in the NSC shall be either in graphical block format or line-programming format or both.

b) The programmer's environment will include access to a superset of the same programming language supported in the SDCUs.

c) NSC devices will support both script programming language as well as the graphical function block programming language. For both languages, the programmer will be able to configure application software off-line (if desired) for custom program development, and write global control programs.

d) It shall be possible to save custom programs as libraries for reuse throughout the system. A wizard tool shall be available for loading programs from a library file in the program editor.

e) It shall be possible to view graphical programming live and real-time from the Workstation.

f) The system shall be capable of creating ‘binding templates’ allowing the user to bind multiple points to multiple objects all at once.

g) Key terms should appear when typing (IntelliType).

h) Applications should be able to be assigned different priorities and cycle times for a prioritized execution of different function.

i) The system shall be able to create objects that allow common objects such as power meters, VFD drives, etc. to be integrated into the system with simple import actions without the need of complicated programming or configuration setups.

**Saving/Reloading**

a) The workstation software shall have an application to save and restore NSC and field controller memory files.

b) For the NSC, this application shall not be limited to saving and reloading an entire controller – it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.

**Audit Trail**

a) The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.

b) It shall be possible to view a history of alarms, user actions, and commands for any system object individually or at least the last 5000 records of all events for the entire system from Workstation.

c) It shall be possible to save custom filtered views of event information that are viewable and configurable in Workstation.

**Fault Tolerant Software Operation (Top level NSC)**

a) A single component failure in the system shall not cause the entire system to fail. All system users shall be informed of any detectable component failure via an alarm.
event. System users shall not be logged off as a result of a system failure or switchover.

xvii. **Web-based Operator Software**

a) General:

- Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network.
- The system shall be able to be accessed on site via a mobile device environment, with, at a minimum, access to overwrite and view system values.

b) Graphic Displays

- The browser-based interface must share the same graphical displays as the Administration and Programming Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser's graphics shall support commands to change setpoints, enable/disable equipment and start/stop equipment.
- Through the browser interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a record of the change stored in the system database.

c) Alarm Management

- Systems requiring additional client software to be installed on a PC for viewing the webstation from that PC will not be considered.
- Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented, if the user’s password allows it. Users must be able to receive alarms, silence alarms, and acknowledge alarms through a browser. If desired, specific operator text must be able to be added to the alarm record before acknowledgement, attachments shall be viewable, and alarm checklists shall be available.

xviii. **Groups and Schedules**

a) Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.

b) Through the browser interface, operators must be able to change schedules – change start and stop times, add new times to a schedule, and modify calendars.

xix. **User Accounts and Audit Trail**

a) The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.

b) All commands and user activity through the browser interface shall be recorded in the system’s activity log, which can be later searched and retrieved by user, date, or both.

xx. **Web Services**

1. The installed system shall be able to use web services to “consume” information within both the Network Server/Controllers (NSCs) and the Administration and
Programming Workstations (APWs) with other products and systems. Inability to perform web services within BOTH NSCs and APWs will be unacceptable.

a. Shall be able to “consume” data into the system via SOAP and REST web services.

b. Shall be able to “serve” and “consume” data from other systems such as:
   i) StruxureWare Data Center Expert
   ii) StruxureWare Power Monitoring Expert

xxi. **Network Server Controllers (NSCs)**

- Network Router Controllers shall combine both network routing functions, control functions, and server functions into a single unit.
- The BACnet NSC shall be classified as a “native” BACnet device, supporting the BACnet Network Server Controller (B-BC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. NSCs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Network Server Controllers (B-BC).
- The Network Server Controller shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NRS.
- They shall also be responsible for monitoring and controlling their own HVAC equipment such as an AHU or boiler.
- They shall also contain graphics, trends, trend charts, alarm views, and other similar presentation objects that can be served to workstations or web-based interfaces. A sufficient number of NSCs shall be supplied to fully meet the requirements of this specification and the attached point list.

**It shall be capable of executing application control programs to provide:**

a) Calendar functions  
b) Scheduling  
c) Trending  
d) Alarm monitoring and routing  
e) Time synchronization by means of an Internet site including automatic synchronization  
f) Native integration of LonWorks controller data and Modbus controller data or BACnet controller data and Modbus controller data  
g) Network Management functions for all LonWorks based devices

xxii. **Hardware Specifications**

a) Memory:

- The operating system of the controller, application programs, and all other portions of the configuration database, shall be stored in non-volatile, FLASH memory. Servers/Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.

b) Each NRC shall provide the following on-board hardware for communication:
- One 10/100bT Ethernet for communication to Workstations, other NRCs and onto the Internet
- Two RS-485 ports for communication to BACnet MSTP bus or serial Modbus (software configurable)
- One TP/FT port for communication to LonWorks devices.
- One Device USB port
- Two host USB Ports

   c) The NSC shall conform to a small footprint no larger than 100W x 125H x 75D mm (3.94W x 4.92H x 2.95D in).

xxiii. Modular Expandability:

   a) The system shall employ a modular I/O design to allow expansion. Input and output capacity is to be provided through plug-in modules of various types. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.

   b) One shall be able to “hot-change” (hot-swap) the I/O modules preserving the system on-line without any intervention on the software; addressing and configuration shall be automatic

xxiv. Hardware Override Switches:

   a) All digital outputs shall, optionally, include three position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall be built into the unit and shall provide feedback to the controller so that the position of the override switch can be obtained through software. In addition each analog output shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3 position manual override switch is placed in the ON position.

xxv. Universal Input Temperatures

   a) All universal inputs directly connected to the NSC via modular expansion shall be capable of using the following thermistors for use in the system without any external converters needed.

      - 10 kohm Type I
      - 10 kohm Type II
      - 10 kohm Type III
      - 10 kohm Type IV
      - Linearized 10 kohm Type V
      - Linearized 10 kohm
      - 1.8 kohm
      - 1 kohm
      - 20 kohm
      - 2.2 kohm
b) In addition to the above, the system shall be capable of using the below RTD sensors, however it is not required that all universal inputs be compatible with them.

- PT100
- PT1000
- Ni1000

xxvi. **Local Status Indicator Lamps:**

a) The NSC shall provide as a minimum LED indication of CPU status, Ethernet LAN status, and field bus status. For each input or output, provide LED indication of the value of the point (On/Off). The LED indication shall support software configuration to set whether the illumination of the LED corresponds to On or Off or whether the color when illuminated is Red or Green.

xxvii. **Real Time Clock (RTC):**

a) Each NSC shall include a battery-backed, real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. Each NSC will allow for its own UTC offset, depending upon the time zone. When the time zone is set, the NSC will also store the appropriate times for daylight savings time.

xxviii. **Power Supply:**

a) The 24 VDC power supply for the NSCs shall provide 30 watts of available power for the NSC and associated IO modules. The system shall support the use of more than one power supply if heavily power consuming modules are required.

b) The power supply, NSC, and I/O modules shall connect power wise and communication wise via the separate terminal base allowing for ease of replacement and no separate or loose wiring.

xxix. **Automatic Restart After Power Failure:**

a) Upon restoration of power after an outage, the NSC shall automatically and without human intervention update all monitored functions, resume operation based on current, synchronize time and status, and implement special start-up strategies as required.

xxx. **Battery backup:**

a) The NSC shall include an on-board battery to back up the controller’s RAM memory. The battery shall provide accumulated backup of all RAM and clock functions for at least 30 days. In the case of a power failure, the NSC shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the NSC shall restart itself from its application program stored in its FLASH memory.

xxxii. **Software Specifications**

a) The operating system of the controller, application programs, and all other portions of the configuration database such as graphics, trends, alarms, views, etc., shall be stored in non-volatile, FLASH memory. There will be no restrictions placed on the type of application programs in the system. Each NSC shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
Each NSC shall have an available capacity of 4 GB of memory. This shall represent 2 GB for application and historical data and 2 GB dedicated for backup storage.

**User Programming Language:**

a) The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be either a script-based structured text or graphical function block based and fully programmable by the user. The language shall be structured to allow for the configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, and histories. Users shall be able to place comments anywhere in the body of either script or function block programs.

b) Network Server Controllers that use a “canned” program method will not be accepted.

**Control Software:**

a) The NSC shall have the ability to perform the following pre-tested control algorithms:
   - Proportional, Integral plus Derivative Control (PID)
   - Two Position Control
   - Digital Filter
   - Ratio Calculator
   - Equipment Cycling Protection

**Mathematical Functions:**

a) Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.

b) NSCs shall have the ability to perform any or all of the following energy management routines:

c) Time of Day Scheduling
d) Calendar Based Scheduling
e) Holiday Scheduling
f) Temporary Schedule Overrides
g) Optimal Start
h) Optimal Stop
i) Night Setback Control
j) Enthalpy Switchover (Economizer)
k) Peak Demand Limiting
l) Temperature Compensated Duty Cycling
m) CFM Tracking
n) Heating/Cooling Interlock  
o) Hot/Cold Deck Reset  
p) Hot Water Reset  
q) Chilled Water Reset  
r) Condenser Water Reset  
s) Chiller Sequencing  

xxxv. History Logging:  
a) Each NSC controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable either over user defined time intervals ranging from 1 second to 1440 minutes or based upon a user configurable change of value. A minimum of 1000 logs, with a minimum of 100,000 records, shall be stored. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to a higher level NSC long term archiving based upon user-defined time intervals, or manual command.  
b) For extended trend logging a minimum of 1500 trends shall be capable, with a minimum number of 600,000 records within.  
c) Management of a power meter replacement to ensure meter log data is accurate shall be possible in the NSC.  
d) Every hardware input and output point shall be trended automatically without the requirement for manual creation, and each of these logs shall log values based upon a change of value and store at least 500 trend samples before replacing the oldest sample with new data.  
e) The presentation of logged data shall be built into the server capabilities of the NSC Presentation can be in time stamped list formats or in a chart format with fully configurable pen colors, weights, scales and time spans.  

xxxvi. Alarm Management:  
a) For each system point, alarms can be created based on high/low limits or in comparison to other point values. All alarms will be tested each scan of the NSC and can result in the display of one or more alarm messages or reports.  
b) There is no limit to the number of alarms that can be created for any point  
c) Alarms can be configured to be generated based upon a single system condition or multiple system conditions.  
d) Alarms will be generated based on an evaluation of the alarm conditions and can be presented to the user in a fully configurable order, by priority, by time, by category, etc. These configurable alarm views will be presented to a user upon logging into the system regardless of whether the log in takes place at a WorkStation or a WebStation.  
e) The alarm management system shall support the ability to create and select cause and action notes to be selected and associated with an alarm event. Checklists shall also be possible in order to present to an operator a suggested mode of troubleshooting. When acknowledging an alarm, it shall be possible to assign it to a user of the system such that the user is notified of the assignment and is made responsible for the alarm resolution.
f) Alarms must be capable of being routed to any BACnet workstation that conforms to the B-OWS device profile and uses the BACnet/IP protocol.

xxxvii. Embedded Web Server

a) Each NSC must have the ability to serve out web pages containing the same information that is available from the WorkStation. The development of the screens to accomplish shall not require any additional engineering labor over that required to show them at the WorkStation itself.

xxxviii. BACnet Fieldbus and BACnet SDCUs

i. Networking

a) IP Network: All devices that connect to the WAN shall be capable of operating at 10 megabits per second or 100 megabits per second.

b) IP To Field Bus Routing Devices

- A Network Server Controller shall be used to provide this functionality.
- These devices shall be configurable locally with IP crossover cable and configurable via the IP network.
- The routing configuration shall be such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.

ii. Field Bus Wiring and Termination

a) The wiring of components shall use a bus or daisy chain concept with no tees, stubs, or free topology.

b) Each field bus shall have a termination resistor at both ends of each segment.

c) The field bus shall support the use of wireless communications.

iii. Repeaters

a) Repeaters are required to connect two segments.

b) Repeaters shall be installed in an enclosure. The enclosure may be in an interstitial space.

iv. Field Bus Devices

a) General Requirements

- Devices shall have a light indicating that they are powered.
- Devices shall be locally powered. Link powered devices (power is furnished from a central source over the field bus cable) are not acceptable.
- Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings. (Battery backup, flash memory, etc.)

v. Network Server Controllers (NSCs)

- If NSCs have embedded I/O, all of the requirements for I/O that are described under Advance Application Controllers shall apply.
- Shall support the export of data to NSCs from other vendors that support the data sharing, read property service.
• Shall support the export of data using Change of Value (COV) initiation to NSCs from other vendors that support the subscription to data using the COV concept.

• Shall support the export of data to any BACnet OWS that supports the data sharing, read property service.

• Shall support the export of data using Change of Value (COV) initiation to any BACnet OWS that supports the subscription to data using the COV concept.

• Shall provide trend log support for all of the devices on the field bus. They shall provide sufficient memory to store up to 300 samples for each variable required to be trended by the sequence of control.

• Shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.

• Shall provide time schedule support for all of the devices on the field bus.

• Shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.

• Shall provide alarm message initiation for all alarms conditions from any of the field bus devices.

• Shall deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient of the notification.

• Shall support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement.

• Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.

• Shall support the receipt and response to Time Synchronization commands from any device that supports the BACnet service for initiating time synchronization commands.

• Shall support the “Who is?” and “I am,” BACnet service.

• Shall support the “Who has?” and “I have,” BACnet service.

• Shall support Backup and Restore commands from any BACnet OWS that supports the initiation of Backup and Restore commands.

• Shall be BTL certified.

vi. **Advance Application Controllers (B-AAC)**

a) The key characteristics of a B-AAC are:

• They have physical input and output circuits for the connection of analog input devices, binary input devices, pulse input devices, analog output devices, and binary output devices. The number and type of input and output devices supported will vary by model.
- They may or may not provide support for additional input and output devices beyond the number of circuits that are provided on the basic circuit board. Support for additional I/O shall be provided by additional circuit boards that physically connect to the basic controller.

- The application to be executed by a B-AAC is created by an application engineer using the vendor’s application programming tool.

- If local time schedules are embedded, the B-AAC shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.

- If local trend logging is embedded, the B-AAC shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.

- If local alarm message initiation is embedded, the B-AAC shall:
  - Deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient off the alarm message.
  - Support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement,

- Shall support the reading of analog and binary data from any BACnet OWS or Building Controller that supports the BACnet service for the reading of data.

- Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.

- Shall support the receipt and response to Time Synchronization commands from a BACnet Building Controller.

- Shall support the “Who is” and “I am.” BACnet services.

- Shall support the “Who has” and “I have.” BACnet services.

b) Analog Input Circuits

- The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.

- For non-flow sensors, the control logic shall provide support for the use of a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).

- For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).
• For non-linear sensors such as thermistors and flow sensors the B-AAC shall provide software support for the linearization of the input signal.

c) Binary Input Circuits

• Dry contact sensors shall wire to the controller with two wires.
• An external power supply in the sensor circuit shall not be required.

d) Pulse Input Circuits

• Pulse input sensors shall wire to the controller with two wires.
• An external power supply in the sensor circuit shall not be required.
• The pulse input circuit shall be able to process up to 20 pulses per second.

e) True Analog Output Circuits

• The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliamps or 0 to 20 milliamps or to ranges within the full output range (Example: 0 to 100% creates 3 to 6 VDC where the full output range is 0 to 10 VDC).
• The resolution of the D/A chip shall not be greater than 0.04 Volts per increment or 0.08 milliamps per increment.

f) Binary Output Circuits

• Single pole, single throw or single pole, double throw relays with support for up to 230 VAC and a maximum current of 2 amps.
• Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.5 amps at 24 VAC.

g) Program Execution

• Process control loops shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
• The sample rate for a process control loop shall be adjustable and shall support a minimum sample rate of 1 second.
• The sample rate for process variables shall be adjustable and shall support a minimum sample rate of 1 second.
• The sample rate for algorithm updates shall be adjustable and shall support a minimum sample rate of 1 second.
• The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of a power cycle to modify the sequence of controller immediately following a power cycle.

h) Local Interface

• The controller shall support the connection of a portable interface device such as a laptop computer or unique hand-held device. The ability to execute any tasks other than viewing data shall be password protected. Via this local interface, an operator shall be able to:
  • Adjust application parameters.
• Execute manual control of input and output points.
• View dynamic data.

vii. Application Specific Devices

a) Application specific devices shall have fixed function configurable applications.

b) If the application can be altered by application programmable tool, the device is an advanced application controller and not an application specific device.

c) Application specific devices shall be BTL certified.

h) Field Hardware - DCUs

1. DCUs (Distributed Control Units) - All points in the system shall be monitored and/or controlled through "intelligent" Distributed Control Units (DCU's). Each DCU in the system shall contain its own microprocessor and memory with a minimum 300 hours battery backup. Each DCU in the system shall be a completely independent stand-alone "master" with its own hardware clock calendar and all firmware and software to maintain complete control on an independent basis. Each DCU shall include the following capabilities:

a) Acquire, process, and transfer information to the PC operator work stations or other DCU's on the network.

b) Accept, process, and execute commands from the other DCU's or other input devices, or multiple PC work stations.

c) Allow access to both data base and control functions by multiple work stations at the same time.

d) Record, evaluate, and report the changes of state and/or value that occur among points associated with the DCU. If any operator work station or transmission network fails, but the power to the DCU does not, the DCU shall continue to perform all control functions associated with the points to which the DCU remains connected.

e) Specifically, a DCU shall contain memory and processing capability to perform in a stand-alone mode:

i. Scheduled stop/start

ii. Adaptive optimized start/stop

iii. Duty cycling

iv. Automatic temperature control

v. Demand control

vi. Event initiated control

vii. Calculated point

viii. Scanning and alarm processing

ix. Full direct digital control

x. Trend logging

xi. Global communications

xii. Maintenance scheduling

2. Each DCU shall have the ability to transmit any or all 110 points as global points onto the network for use by other DCU's and to utilize data from other panels as
part of its database. To maximize system throughput, and minimize unnecessary
network traffic, analog inputs shall be transmitted only after an operator
specified change of value has occurred since the last broadcast value. This
change of value threshold shall be operator selectable on a per point basis.

3. DCU Field Input/Output Capability: The following point types must be supported
by the DCU’s.
   • Discrete digital input (contract status)
   • Discrete digital output (maintained, momentary, dual momentary, floating)
   • Analog input (0-20 mA, or 0-5 VDC or 0-IOVDC with 12-bit A/D
collection resolution minimum)
   • Analog output (0-10 VDC with 8-bit D/A resolution minimum)
   • Pulse input capable of accepting 10 pulses/second and accumulating total.
   • Pulse Width Modulation (PWM) output capable of producing a pulse
anywhere between 0-655 seconds in duration with 0.01 second resolution.
   • Every discrete digital output and PWM output shall have a separate switch with
   individual feedback as to the position of the switch, unless the DCU has an
   integral keypad display device.

4. Each DCU shall have the ability to monitor, control or address not less than
300 data points.

5. DCU Point Scanning: It shall be possible to independently set the scan or
execution speed for each point in the DCU to an operator selected time from
1 to 254 seconds.

6. DCU Diagnostics: provide diagnostics which support the following dynamic
(one second refresh) parameters:
   a. Processor loading
   b. LAN Loading
   c. Memory data

7. DCU Test Mode Operation: Each DCU shall have the ability to place
input/output points in a test mode. The test mode shall allow control
algorithms to be tested and developed on line without disrupting the field
hardware and controlled environment. The treatment of all 110 points in
the test mode shall be as follows:
   a. Scanning and calculation of all input points in test mode shall be inhibited.
Manual control of input points in test mode will allow setting the analog
or digital input point to an operator determined test value, which can be
issued from any fixed or portable operator console.
   b. It shall be possible to control all output points, but only the data base
state/value shall be changed, the external field hardware is left
unchanged. Failure to provide test mode capability will preclude acceptance.

8. Field Hardware – MCs

i. MicroControllers (MCs) shall be connected to the Controller LAN via a Micro Controller Interface (MCI). The MCI shall be a DCU without any directly connected points. MCs shall be connected to the MCI via a high speed, RS-485 sub-network. For system reliability, distribution of risk, and high throughput, not more than 64 MCs shall be connected to any single MCI, and this MCI shall not share processors or Controller LAN interfaces with a DCU that is hardwired to primary equipment.

ii. The MCI shall provide common and memory intensive functions for locally connected MCs, including: time scheduling, custom or global calculations, and historical data collection. The operator interface for all MCI database entry and application programs shall be fully integrated and consistent with other DCUs.

iii. The MCI shall support sub-networks consisting of counter-scanning loops for increased system availability. Upon a single break (i.e., severed wire) the MCI shall scan the loop in both the primary and secondary directions and maintain communications with all MCs -not just those located between the MCI and the fault.

iv. Micro Controllers (MCs) shall be utilized for zone or terminal equipment only. Applications requiring more than 8 inputs and 8 outputs are not considered zone or terminal and must be treated as "Primary" equipment applications, which require direct connection to a DCU on the Controller LAN. Micro applications include:

   a. Fan-coils, unit ventilators, unit heaters, small packaged AHUs, split system AHUs, rooftop AHUs

Xxxix DDC Sensors and Point Hardware:

   a) Temperature Sensors

   b) All temperature devices shall use precision thermistors with accuracy level and range corresponding to the best OEM Standards.

   c) Room Sensor: Standard space sensors shall be available in an [off white][black] enclosure made of high impact ABS plastic for mounting on a standard electrical box.

      • Where manual overrides are required, the sensor housing shall feature both an optional sliding mechanism for adjusting the space temperature setpoint, as well as a push button for selecting after hours operation.

      • Where a local display is specified, the sensor shall incorporate an LCD display for viewing the space temperature, setpoint and other operator selectable parameters. Using built in buttons, operators shall be able to adjust setpoints directly from the sensor.
d) Duct Probe Sensor: Sensing element shall be fully encapsulated in potting material within a stainless steel probe.

e) Duct Averaging Sensor: Averaging sensors shall be employed in ducts which are larger than 14 square feet. The averaging sensor tube shall contain at least one thermistor for every 3 feet, with a minimum tube length of 6 feet. The averaging sensor shall be constructed of rigid or flexible copper tubing. Pipe Immersion Sensor: Immersion sensors shall be employed for measurement of temperature in all chilled and hot water applications as well as refrigerant applications. Provide sensor probe length suitable for application.

f) Outside Air Sensor: Provide the sensing element on the building’s north side. Sensing element shall be fully encapsulated in potting material within a stainless steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure. It shall have operating range corresponding to best OEM Standards.

g) A pneumatic signal shall not be allowed for sensing temperature.

h) Humidity Wall Transmitter

- Transmitters shall have accuracy level corresponding to best OEM Standards.
- Transmitter shall have replaceable sensing element.
- Sensor type shall be thin-film capacitive.
- Sensor element shall contain multipoint calibration on-board in nonvolatile memory
- Operating range shall as per best OEM Standards.
- Output shall be field selectable with range corresponding to best OEM Standards.
- Transmitter shall accept 12-30 VDC or 24 VAC supply power.
- Transmitter shall be available in an off white/black enclosure made of high impact ABS plastic for mounting on a standard electrical box.
- Transmitter shall have LCD display
- Transmitter shall have integrated temperature sensor

i) Humidity Duct Transmitter

- Transmitters shall have accuracy level corresponding to best OEM Standards.
- Transmitter shall be fully encapsulated in potting material within a stainless steel probe.
- Transmitter shall have replaceable sensing element.
- Sensor type shall be thin-film capacitive.
• Sensor element shall contain multipoint calibration on-board in nonvolatile memory
• Operating range shall as per best OEM Standards.
• Output shall have range corresponding to best OEM Standards.
• Transmitter shall accept 12-30 VDC or 24 VAC supply power.
• Transmitter shall be available with a certification of NIST calibration
• Transmitter shall have integrated temperature sensor

j) Humidity Outdoor Transmitter
• Transmitters shall have accuracy level corresponding to best OEM Standards.
• Transmitter shall be fully encapsulated in potting material within a stainless steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure.
• Transmitter shall have replaceable sensing element.
• Sensor type shall be thin-film capacitive.
• Sensor element shall contain multipoint calibration on-board in nonvolatile memory
• Operating range shall be as per best OEM Standards.
• Output shall be 4-20 mA or 0-5/0-10 VDC.
• Transmitter shall accept 12-30 VDC or 24 VAC supply power.
• Transmitter shall have integrated temperature sensor

k) Liquid Differential Pressure Transmitters:
• Transmitter shall be microprocessor based
• Transmitter shall use two independent gauge pressure sensors to measure and calculate differential pressure
• Transmitter shall have minimum 4 switch selectable ranges
• Transmitter shall have test mode to produce full-scale output automatically.
• Transmitter shall have provision for zeroing by pushbutton or digital input.
• Transmitter shall have field selectable outputs of 0-5V, 0-10V, and 4-20mA.
• Transmitter shall have field selectable electronic surge damping
• Transmitter shall have an electronic port swap feature
• Transmitter shall accept 12-30 VDC or 24 VAC supply power
• Sensor shall be 17-4 PH stainless steel where it contacts the working fluid.

l) Performance:
• Accuracy shall be as per best OEM Standards.
• Long term stability shall be as per best OEM Standards.
• Sensor temperature operating range shall be as per best OEM Standards.
• Operating environment shall be as per best OEM Standards.
• Proof pressure shall be as per best OEM Standards.
• Burst pressure shall be as per best OEM Standards.

m) Transmitter shall be encased in a NEMA 4 enclosure.
CHAPTER- O

TECHNICAL SPECIFICATIONS -WTP/STP/ETP/SOLAR HOT WATER SYSTEM/HEAT PUMP

A. WATER TREATMENT PLANT GENERAL REQUIREMENTS

A.1. SCOPE OF WORK

Design, Engineering Supply, Installation, Testing & Commissioning of WTP shall be carried out by the Contractor on EPC Basis & as directed by Engineer-in-charge.

A.1.1. Work 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 specialised services as described hereinafter and as specified in the DBR and/or shown on the plumbing drawings.

A.1.2. Without restricting to the generality of the foregoing, this section shall include the following:-

   i. Hydropneumatic/Monoblock Water supply Pumps
   ii. Filters (dual media/activated carbon/pressurized sand), Softeners, UV dosing etc.
   iii. Pumps & Allied Equipment
   iv. STP & ETP
   v. Solar Hot Water System
   vi. RO System (Centralized & Portable)
   vii. Heat Pumps

A.2. SPECIFICATION

A.2.1. Work under this Contract shall be carried out strictly in accordance with specifications attached with the tender.

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

A.2.3. Works not covered under Paras above shall be carried out as per relevant Codes & Bureau of Indian Standards and in case of its absence as per British Standard Code of Practice.

A.3. EXECUTION OF WORK

A.3.1. The Contractor should visit and examine the site of work and satisfy himself as to the nature of the existing roads and other means of communication and other details pertaining to the work and local conditions and facilities for obtaining his own information on all matters affecting the execution of work.

A.3.2. The work shall be carried out in conformity with the Plumbing drawings and within the requirements of architectural and coordinated with all services drawings.

A.3.3. The Contractor shall cooperate with all trades and agencies working on the site. He shall make provision for hangers, sleeves, structural openings and other requirements well in advance to prevent hold up of progress of the construction schedule. All supports to the civil structure shall be provided with dash fasteners.

A.3.4. On award of the work, Contractor shall submit a schedule of construction in the form of a PERT chart or BAR chart for approval of the Engineer-In-Charge/ HITES. All dates and time schedule agreed upon shall be strictly adhered to within the stipulated time of
A.4. DRAWINGS

A.4.1. Tender drawings/Schematic of WTP/ETP/STP/Hot water system are provided to the Contractor. On the basis of these, shop drawings will be prepared & submitted to Engineer-in-charge/HITES for approval. The execution of work shall be done in–line with the approved shop drawings.

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

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

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

A.4.5. Any drawings issued by the Engineer-in-charge/HITES for the work are the property of the Engineer-in-charge/ HITES and shall not be lent, reproduced or used on any works other than intended without the written permission of the Engineer-in-charge/HITES.

A.5. REFERENCE DRAWINGS

A.5.1. The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on site. All important drawings shall be mounted on boards and placed in racks indexed. No drawings shall be rolled.

A.5.2. All corrections, deviations and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings to be submitted by the contractor in fulfilment of the conditions of this contract.

A.5.3. On award of the work the contractor shall be issued, one set of HITES's working drawings stamped “tender drawings” by the Engineer-In-Charge. The HITES's drawings shall be the basis of contractor's shop drawings. Upon submission of shop drawings to HITES, Final approved drawings will be stamped as “Good for Construction” drawings, based on which execution work will be done.

A.5.4. Shop drawings are detailed working drawings which incorporate the contractor’s details for execution of the work and incorporate equipment manufacturer’s details and dimensions to ensure that the same can be installed in the space provided.

A.5.5. All shop drawings should detailed pipe routing and levels, showing location of other services at crossings etc., cable runs, route cable trays and all allied works and must be fully co-ordinated with other services and approved by the Engineer-In-Charge before execution of the works. The Contractor shall submit services drawings (if required for coordination of services) from their respective contracting agencies. All drawings will valid only when stamped and issued by the Engineer-In-Charge.

A.5.6. Shop drawings shall be furnished for detailed layout of all equipment, foundation, bolting and vibration elimination details along with information on dead and dynamic load, vibration etc.

A.5.7. Two sets of manufacturer’s equipment drawings, roughing in and wiring diagrams shall be submitted.

A.5.8. Contractor shall submit shop drawings furnishing all details of MCC panels, cable routes, wiring diagrams and connection details as required.

A.5.9. Two copies of each set of shop drawings shall be submitted for initial scrutiny, discussion
and approval.

A.5.10. Each submission shall be accompanied by contractor’s certificate stating that the shop drawings meet all the contract requirements and that the piping and equipment can be satisfactorily installed without any obstructions in the space available.

A.5.11. On approval of the above the contractor shall furnish three sets of the approved shop drawings for execution of the work.

A.6. INSPECTION AND TESTING OF MATERIALS

A.6.1. Contractor shall be required, if requested, to produce manufacturers test certificate for the particular batch of materials supplied to him. The tests carried out shall be as per the relevant Bureau of Indian Standards.

A.6.2. For examination and testing of materials and works at the site Contractor shall provide all testing and gauging equipment necessary but not limited to the following:

a) Steel tapes
b) Weighing machine
c) Plumb bobs, sprit levels, hammer
d) Micrometers
e) Hydraulic machine

A.6.3. All such equipment shall be tested for calibration at any approved laboratory, if required by the Engineer-In-Charge. All testing equipment shall be preferably located in special room meant for the purpose.

A.6.4. Samples of all materials shall be got approved before placing order and the approved samples shall be deposited with the Engineer-In-Charge.

A.7. METRIC CONVERSION

A.7.1. All dimensions and sizes of materials and equipment given in the tender document are commercial metric sizes.

A.7.2. Any weights, or sizes given in the tender having changed due to metric conversion, the nearest equivalent sizes accepted by Indian Standards shall be acceptable without any additional cost.

A.8. COMPLETION DRAWINGS

A.8.1. On completion of work, Contractor shall submit one complete set of original tracings and four prints of "as built" drawings to the Project Manager. These drawings shall have the following information.

a) Run of all piping, diameters on all floors, vertical stacks and location of external services.

b) Ground and invert levels of all drainage pipes together with location of all manholes and connections up to outfall.

c) Run of all water supply lines with diameters, locations of control valves, access panels.

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

e) All shop drawings shall be updated from time to time for the purpose of making completion drawings.
A.8.2. Contractor shall provide four sets of catalogues, service/operation & maintenance manuals, manufacturer’s drawings, performance data and list of spare parts together with the name and address of the manufacturer for all electrical and mechanical equipment provided by him.

A.8.3. All "warranty cards" of pumps & other major equipment given by the manufacturers shall be handed over to the Engineer-In-Charge.

A.9. TESTING

A.9.1. Piping and drainage works shall be tested as specified under the relevant clauses of the specifications.

A.9.2. Tests shall be performed in presence of the Engineer-In-Charge and test records for the tests shall be duly signed by Contractor and the Engineer-In-Charge.

A.9.3. All materials and equipment found defective shall be replaced and whole work tested to meet the requirements of the specifications.

A.9.4. Contractor shall perform all such tests as may be necessary and required by the local authorities to meet municipal or other bye-laws in force.

A.9.5. Contractor shall provide all labour, equipment and materials for the performance of the tests.

A.10. SITE CLEARANCE AND CLEANUP

A.10.1. The Contractor shall, from time to time, clear away all debris and excess materials accumulated at the site.

A.10.2. After the fixtures, equipment and appliances have been installed and commissioned, Contractor shall clean-up the same and remove all plaster, paints, stains, stickers and other foreign matter or discoloration leaving the same in a ready to use condition.

A.10.3. On completion of all works, Contractor shall demolish all stores, remove all surplus materials and leave the site in a broom clean condition, failing which the same shall be done by the Engineer-In-Charge at the Contractor’s risk and cost. Cost of the cleanup shall be deducted from the contractor’s bills on pro-rata basis in proportion to his contract value.

A.11. LICENCE PERMITS AND AUTHORITIES

A.11.1. Contractor must hold a valid plumbing or any other as required licence by the municipal authority or other competent authority under whose jurisdiction the work falls.

A.11.2. Contractor must keep constant liaison with the local development, municipal /statutory authority and obtain approval of all drainage, water supply, fire suppression and other works carried out by him.

A.11.3. Contractor shall obtain, from the municipal and other authorities 'C' & 'D' & other forms as required for approval of drainage and water supply works during execution and the completion certificate with respect to his work as required for occupation of the building. Contractor shall obtain permanent water supply and drainage connections from authorities concerned. CLIENT/ HITES shall reimburse the fees paid to the authorities towards the connection charges on production of receipts for money paid.

A.11.4. Contractor shall get any materials tested from the appropriate authority if so required with no cost to the CLIENT/HITES.

A.12. CUTTING OF WATER PROOFING MEMBRANE:

A.12.1. No walls terraces shall be cut for making and opening after water proofing has been
done without written approval of Engineer-In-Charge. Cutting of water proofing membrane shall be done very carefully so as other portion of water proofing is not damaged. On completion of work at such place the water proofing membrane shall be made good and ensured that the opening/cutting is made fully water proof as per specifications and details of water proofing approved by Engineer-In-Charges.

A.13. MATERIALS

A.13.1. Unless otherwise specified and expressly approved in writing by the Engineer-In-Charge, only materials of makes and specification as mentioned in the list of approved makes attached with the specifications shall be used.

A.13.2. If required, the Contractor shall submit samples of materials proposed to be used in the works. Approved samples shall be kept in the office of the Engineer-In-Charge.

B. WATER SUPPLY, FLUSHING/IRRIGATION PUMPS & EQUIPMENT

B.1. GENERAL REQUIREMENTS

B.1.1. All materials shall be new of the best quality conforming to specifications and subject to the approval of Engineer-In-Charge.

B.1.2. All equipment shall be of the best available make manufactured by reputed firms.

B.1.3. All equipment shall be installed on suitable foundations true to level and in a neat workmanlike manner.

B.1.4. Equipment shall be so installed as to provide sufficient clearance between the end walls and between equipment to equipment.

B.1.5. Piping within the pump house shall be so done as to prevent any obstruction in the movement within the pump house.

B.1.6. Each pumping set shall be provided with a butterfly valve on the suction and delivery side and a flap type non return valve on the delivery side.

B.1.7. All pump couplings and belt guards for air compressors shall be totally enclosed with 5 mm mesh.

B.2. SYSTEM OF WATER SUPPLY

B.2.1. The water supplied by the authorities will be stored in the domestic U.G. tank.

B.2.2. Water from this U.G. tank shall be pumped to O.H. Tanks at terrace of each building by separate pumps/sump.

B.2.3. Each toilet and kitchen shall be fed with water from terrace tanks by gravity. Top two floors of the Hospital Building will be fed by Hydro-pneumatic System from terrace.

C. RISING MAINS & LEVEL CONTROL SYSTEM

C.1. Water from the pumps described above will fill each tank by a rising main to each tower.

C.2. 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.3. 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.

D. LEVEL CONTROLLERS

D.1. 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:-

D.1.1. Provide a 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

D.2. **Overhead tank level controller cum indicators**

D.2.1. 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:

D.2.2. 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.

D.2.3. 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.

D.2.4. Indicate the water level in each OHT in the level indicating panel installed in the pump room

D.2.5. Each OHT are also provided with motorized valve for filling of Over Head Water tank complete with high and low level control switches to control the valve. The level controllers shall be installed in overhead tanks. The level switch will close the valve when water level is high (Top Water Level) in over head tank and open the valve when over head water tank level is low (30% of storage capacity). The system should be complete in all respects with accessories, 220 V AC / 24 V DC, IP67 electrical water level control unit, copper control wiring in whether proof casing etc.

D.3. **Control & Indicating Panel (For overhead and underground water tanks)**

D.3.1. 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:

D.3.2. Digital level indicator panel meter for each water tank.

D.3.3. Etched plate identification plates.

D.3.4. Control cabling from MCC to the panel installed in the control room as directed by the Engineer-in-Charge.

D.3.5. Cabling from PHT sensing probes to the panel

E. **FILTERS-DUAL MEDIA/ACTIVATED CARBON/PRESSURIZED SAND TYPE & SOFTENER**

E.1. **Pressure filters for Water Supply System**

E.1.1. Pressure filters shall be manufactured with factory made bobbin wound polyester fibre glass multilayer filters fitted with internal GI distribution pipe with polypropylene diffusers on top, collector pipes and arms, inlet and outlet header vertical water pressure dished ends complete with initial charge of filter media,
G.I. face piping, accessories testing and commissioning complete, Working Pressure 3.5 kg/cm² (Test pressure 5 kg/cm²). Along with Butterfly Valve/NRV or Dual Plate Check Valve & Gauge etc.

**E.1.2.** Each vessel will be provided with suitable pressure tight manhole cover appropriately located for inspection and repairs.

**E.1.3.** The diameter and height of each vessel shall be as per the design requirement and as per site conditions.

**E.2. Multi-Port Valves**

**E.2.1.** Each vessel will be provided with multi-port valves to operate and regulate the normal flow, backwash and rinsing, rapid washing, on the face piping.

**E.2.2.** Provide suitable sampling cocks to draw water samples for raw water and treated water.

**E.3. Face Piping**

**E.3.1.** Each vessel shall be provided with non-corrosive face piping from the inlet to the outlet. Face piping shall be CPVC (IS 4985)/UPVC/GI 10 kg/cm² all CPVC/UPVC/GI fittings are heavy grade to pipe and solvent weld and flanged joints.

**E.3.2.** All valves shall be butterfly valves as specified in the piping section over 50 mm dia. And above and for pipe dia. below 50 mm dia. shall be provided with ball valves.

**E.4. Water Filtration Plant (For Domestic Water)**

**E.4.1.** Design parameters for the proposed filter shall be as follows:

i. Filter media:- Graded aggregate of required size selected coarse and fine silica sand as per latest water treatment practice. Aggregate and sand to be acid washed and having purity of 99.9%.

ii. Depth of filter media:- Approx. 750-900 mm deep (as per manufacturer’s design)

iii. Back washing :- By air scouring through air blower (approx. 5.1 lpm/m² of filter surface area and water supply from raw water pumps by reverse flow

iv. Output Water Quality for Domestic Filters: To conform to IS 10500 for the relevant design criteria.

**E.5. Chemical Dosing Pumps**

**E.5.1.** Dosing system comprising of an electronic metering pump with, 100 lit capacity uPVC/HDPE solution tank with level gauge and lid on top.

**E.5.2.** Electronic driven metering pumps with mechanically actuated diaphragm with oil lubricated gear mechanism. The output of the pump should be adjustable for operation from 10-100%. Pump construction shall be corrosion resistant polypropylene or similar material. Pump electrical circuit shall be interlocked with the main raw water/pool recirculation pumps so that they operate only when the pumps are operating.

**E.6. Air Blower for Back Washing**

**E.6.1.** Low pressure air blower with TEFC electrical motor, belt driven or direct drive, all mounted on a common structural based plate with oil and water separator.

**E.6.2.** Air blowers will be used for back washing operations. The air blower shall be
designed for operation of one filter at a time. Blowers will be designed for air flow of approx 5.1 lpm/m² air capacity at 0.5 kg/cm² pressure. (This may be modified to suit manufacturer’s requirement for filters offered.)

E.6.3. The electrical switchgear shall be included in the respective MCC panel of the system.

E.7. Softener:

E.7.1. Specifications shall be as per requirements. As per discharge & head, HOS shall be decided, dimension of shell shall be accordingly selected, optimum Resin quantity should be selected with required OBR provisions to be considered. Softener shall be of MS with inner shell FRP lined. It should be provided with backwash, regeneration facility.

Max. Working pressure: 3.5 Kg/cm²
Min. Working pressure: 2.0 Kg/cm²

E.7.2. Output water parameters should be as per GRIHA norms & relevant IS standards.

F. PUMPS

F.1. WATER TRANSFER PUMPS

F.1.1. Water supply pumps shall be suitable for clean filtered water. Pumps shall be single stage, monobloc vertical/horizontal, centrifugal pumps with cast iron body and bronze-gunmetal impeller, stainless steel shaft and mechanical seal and coupled to a TEFC electric motor. Each pump should be operating to a curve required by the operating conditions. MOC stated in DBR for pumps will be deemed as final.

F.1.2. All parts in contact with water shall be corrosion resistant stainless steel DIN-Nr.1.4401.

F.1.3. Each pump shall be provided with a totally enclosed fan cooled induction motor of suitable H.P. The motors shall be suitable for 410 volts, 3 phases, 50 cycles A.C. power supply and shall conform to IS 325 operating at 1450 RPM nominal speed.

F.1.4. Each pumping set shall be provided with 100-mm dia gunmetal “Bourden” type pressure gauge with gunmetal valve and connecting piping.

F.1.5. Pump or the whole set shall be stable on rubber vibration eliminating pads appropriate for each pump as recommended by the manufacturer and accepted by the Engineer-In-Charge.

F.2. SUBMERSIBLE PUMPS

F.2.1. Submersible pumps for clear water transfer shall be single stage, submersible centrifugal Pump of closed coupled construction with C.I. casing and Gun Metal/bronze impeller connected to a fully submersible water/oil cooled motor.

F.2.2. Stuffing box shall be provided with mechanical seals.

F.2.3. Each pump shall be provided with water cooled Squirrel Cage Induction Motor suitable for 415 Volts, 3 phase, 50 cycles AC power supply.

F.2.4. Each pump shall be provided with liquid level controller for automatic operation of the pump between predetermined levels. Operation of level controller shall be similar to as discussed in subsequent paras below.

F.2.5. The pumping set shall be for stationary application and shall be provided with pump connector in it. The delivery pipe shall be joined to the pump through a rubber
diaphragm, and bend and guide pipe for easy installation, without disturbing delivery pipe the pump unit shall have a back pull out design. A rust proof chain shall be provided for each pump.

F.2.6. Pump shall be provided with all accessories and devices necessary and required for the pump to make a complete working system.

F.2.7. The Pump shall be located at a position directly beneath the manhole to ensure proper accessibility.

G. HYDROPNEUMATIC SYSTEM

G.1. PRESSURISED WATER BOOSTING SYSTEM USING VARIABLE SPEED DRIVE

i. The booster set shall consist up to a maximum of six identical vertical multistage in-line pumps in cast iron GG20 pump head & base c/w cataphoresis coating, cartridge type mechanical seal, all internals in AISI 304 stainless steel, mounted on common galvanised steel base frame and controlled by variable frequency drives & a PFU (Pump Functional Unit) logic controller, which have features like application optimised software, regular optimization of operating conditions and read-out of operating data, Bus Communication possibility, Digital remote-control functions, pump & system monitoring functions, Display, Alarm & signal functions and clock programs. Panel to have 2x24 character LCD display, green & red LED’s for operating & fault indication, potential free contacts for remote interfacing, an inbuilt lifetime battery backup for all clock functions.

ii. Booster set should include non return valves, isolating valves, pressure transmitter on discharge side, non-return valve, pressure gauge all mounted on a factory assembled SS manifolds.

iii. Booster set should ensure constant pressure on discharge side through continuously variable adjustment of speed of one of the pumps, while the remaining pumps in operation are running on mains operating at full speed to bring about pump performance to meet consumption levels. Also provision should be made for alternate change over between pumps in operation once every 24 hours & frequency converter operation of pumps by rotation - all should be built in, cyclically, in the controls to ensure equal wear and tear of all pumps in the booster set. Means should be provided for friction loss compensation for increased consumption rate.

iv. Booster set should incorporate following “Power saving features” as standard.

- Selection of 3 basis set points for pressure relative to time.
- Pipe compensation i.e. Change of set point depending on water consumption.
- Compulsory change of staring of sequence, i.e. Equal operating time for pump both for frequency control and ON/OFF regulation.
- Inputs and outputs for external communication.

A small sized pressure tank, (accumulator) to provide for reducing impact of water hammer and minimize short cycling of the pumps. The accumulators are piped to allow for in service maintenance.

The functions of the Controller should incorporate the following features,

- Closed loop control.
- On / Off operation at low flow.
- Automatic cascade control of pumps.
• Selection of switching sequences, automatic pump change and pump priority.
• Manual Operation.
• Analog set point influence
• Friction loss compensation
• Set point adjustment

The remote control functions should have the following features,
• System On / Off
• Set point control
• Switching of individual pumps
• The monitoring functions should have the following features,
  • Min / Max Levels
  • Pre pressure
  • Motor protection
  • Water shortage monitoring

**Enclosure Class**: Control Box IP 54
**Motors**: IP 55

**G.2. PIPE & FITTINGS (FOR HEADERS AND CONNECTIONS)**

**G.2.1.** Pump suction and delivery headers shall be Galvanized iron pipes/MS heavy class with matching fittings. The pipe joints shall be threaded as per manufacturer’s instructions.

**G.2.2. Vibration Eliminators**

All suction and delivery lines as shown on the drawings shall be provided with double flanged reinforced neoprene flexible pipe connectors. 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 details.

**G.2.3. Valves**

**G.2.3.1. 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

**G.2.3.2. 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 Stainless Steel
iv. The shaft to be Stainless Steel
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.

G.2.3.3. Non Return Valves (NRV PN 1.6 rating)

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/sqcm, 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.

7.2.3.4 Pressure gauge (Bourdon Type)

Pressure Guage 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 guage 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/Sqcm.

7.2.3.5 Ball Valves

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/sqcm, 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.

7.2.3.6 ‘Y’ Strainers (PN 1.6 rating)

Cast iron ‘Y’ type strainers (with double flanged construction) with gunmetal internal strainers, CI screwed plug to be provided on all water tank suction connections to pumps. It shall have large screening areas to increase efficiency & it shall have minimum pressure drop inside the body due to streamlined body contours. The test pressure for shell shall be 15 Kg/Sqcm. The maximum working pressure shall be 16 kg/sqcm & maximum working temperature shall be 220 degree celcius.

7.3 PAINTING AND CLEANUP

a) On completion of the installation contractor shall scrub clean all pumps, piping, filters and equipment and apply one coat of primer.
b) Apply two or more coats of synthetic enamel paint of approved make and shade on steel pipes.

c) Provide painted identification legend and direction arrows on all equipment and piping as directed by Engineer-in-Charge.

d) On final completion of the work, contractor should cleanup the site, filter room of all surplus materials rubbish and leave the place in a broom-clean condition.

7.4 CABLES

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

b. Cable size shall be as per functional requirements.

c. XLPE Cables shall be provided conforming to I.S. 7098.

d. Wiring cables shall conform to IS 694.

e. All power/control wiring & cables shall be aluminum conductor XLPE insulated armoured and PVC sheathed of 1100 volts grade.

f. All cables shall have stranded conductors. The cables shall be in drums as far as possible and bear manufacturer’s name.

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

7.5 EARTHING

All equipment installed by the contractor shall be suitably earthed by making proper connection by means of G.I. Wires to the main earthing system laid by the electrical contractors.

7.6 MOTOR CONTROL CENTRES

i. Switchboard cubicles of approved type shall be fabricated from 2 mm M.S. Sheet with dust and vermin proof construction. It shall be painted with stove enamelled paint of approved make and shape. It shall be fitted with suitable etched plastic identification plates for each motor. The cubicle shall comprise of the following: -

a. Incoming main switch fuse unit of required capacity.

b. Isolation switch fuse unit, one for each motor.

c. Fully automatic DOL/star delta starters suitable for motor H.P. with push buttons one for each motor and on/off indicating neon lamps.

d. Single phasing preventer of appropriate rating for each motor.

e. Rotary duty selector switch.

f. Panel type ampere meters one for each motor.

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 and indicating lamp for each motor.

i. Rotary switch for manual or auto operation for each pump.

j. Fully taped separate aluminium bus bars of required capacity for normal and emergency supply where specified.
k. The panel shall be prewired with colour coded wiring. All interconnecting wiring from incoming main to switch gear, meters and accessories within the switch board panel. All switch gears and accessories shall be approved make.

ii. Switchboard cubicles shall be floor or wall mounted type as recommended by manufacturers.

iii. All switch gears and accessories shall be approved make.

H. INSTALLATION, COMMISSIONING & GUARANTEES

8.1 INSTALLATION

8.1.1 Contractor shall supply required number of copies of foundation drawings giving weight, vibration and other loads required for the proper designing of the foundations.

8.1.2 All equipment shall be installed in a true workman like manner true to level and grade in accordance with the best current practice.

8.1.3 Contractor shall employ sufficient and proper equipment for lifting and placing of heavy equipment and in a manner which shall not strain or cause damage to the existing structures. If any damage is done, the same shall be made good to the satisfaction of the Engineer-In-Charge without any additional cost.

8.1.4 All equipment and pipes shall be painted with one coat of red oxide before dispatch to the site.

8.2 COMMISSIONING

8.2.1 On completion of the work in all its aspects, the contractor shall start up the equipment in a manner normally done for the continuous operation for a period of not less than 48 hours and shall rectify and adjust the equipment for leakages and balancing the system.

8.2.2 After satisfactory commissioning of the plant, the contractor shall conduct performance tests on the equipment to satisfy the Engineer-In-Charge that all equipment is performing to the rated outputs. Any or all equipments shall be rectified or replaced if the same is are not performing in accordance with the specifications.

8.3 GUARANTEES

8.3.1 On completion of the work contractor shall submit a guarantee covering the quality and performance of all materials supplied and installed under the contract. This guarantee shall cover each and every material whether manufactured by the contractor or not.

8.3.2 Contractor shall specify a suitable procedure to test the rated performance of the equipments and shall provide all necessary equipments, gauges etc. for conducting such tests.

8.3.3 The guarantee shall cover a period of one year from the date of installation and handing over.

8.4 COMPLETION

8.4.1 On completion of the job, the contractor shall hand over to the Engineer-In-Charge the following:-

8.4.1.1 One flow chart drawn in ink on thick paper and mounted in a glass frame showing the flow diagram of the process including legend showing valves to be normally open or closed and instructions for back washing, operation and maintenance of chlorination & other chemical feeding pumps and other equipments.

8.4.1.2 Five sets of operating and maintenance instructions with spare parts list and their
manufactures and/or suppliers.

8.4.1.3 Five sets of catalogues and drawings for all equipment supplied.

I. WATER TREATMENT PARAMETERS

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Parameters</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td>6.5 – 8.5</td>
</tr>
<tr>
<td>2</td>
<td>Total Dissolved Solids</td>
<td>400 ppm</td>
</tr>
<tr>
<td>3</td>
<td>Suspended solids</td>
<td>&lt; 1 mg/litre</td>
</tr>
<tr>
<td>4</td>
<td>Turbidity</td>
<td>Nil</td>
</tr>
<tr>
<td>5</td>
<td>Total Hardness</td>
<td>Less than 150 ppm</td>
</tr>
</tbody>
</table>

Expected Treated Water Characteristics after Filtration and Softener (For Cooling Tower Make-up)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Parameters</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td>6.0 – 7.0</td>
</tr>
<tr>
<td>2</td>
<td>Total Dissolved Solids</td>
<td>200 ppm</td>
</tr>
<tr>
<td>3</td>
<td>Suspended solids</td>
<td>&lt; 1 mg/litre</td>
</tr>
<tr>
<td>4</td>
<td>Turbidity</td>
<td>Nil</td>
</tr>
<tr>
<td>5</td>
<td>Total Hardness</td>
<td>Less than 50 ppm</td>
</tr>
</tbody>
</table>

Expected Treated Water parameters shall be in conformance to relevant IS standards & GRIHA Norms.

J. TECHNICAL INFORMATION

Please furnish full details separately

All information should be on the following format

PUMPS

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Description</th>
<th>Domestic Water Pump</th>
<th>Irrigation Pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Design basis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Quantity/ No. of units offered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Capacity lit/lpm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>Flow Range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>Pumping Head (where applicable)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>Make &amp; Model No.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>1.6</td>
<td>Power</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.7</td>
<td>Pump Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.8</td>
<td>Material (body)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.9</td>
<td>Material (Impellers)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.10</td>
<td>Material (shafts)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Accessories</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Valves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2</td>
<td>Material (body)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>Material (Internal parts)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.4</td>
<td>Material (Lining)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Pipes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.2</td>
<td>Material</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.3</td>
<td>Max. working pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.4</td>
<td>Max. test pressure</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PIPE COLOUR CODE**

This Colour Code is as per I.S. 2379.

**Ground Colour**
1st Colour Band
2nd Colour band
Proportional width of band 4:1

**Pipe lines**
Ground Color
1st Color
2nd Color
1.
Drinking water (all cold water lines after filter)
Sea green
French blue
Signal red
2.
Treated water (soft water)
Sea green
Light orange
3.
Domestic hot water
Sea green
Light grey

4.
Drainage Sewer /SWD
Black

5.
Fire services
Fire red - This Color Code is as per I.S. 2379

Final design for colour coding will be of CLIENT/ HITES only.
TECHNICAL SPECIFICATIONS OF STP

Design, Engineering Supply, Installation, Testing & Commissioning of STP shall be carried out by the Contractor on EPC Basis & as directed by Engineer-in-charge.

Note: GRIHA norms & relevant IS standards (output water for irrigation/ flushing/ sewer/ portable) for output water parameters should be complied with.

The Sewage Treatment Plant shall be designed on MBR technology for the following raw sewage flow rate and characteristics:

1. SEWAGE GENERATION AND CHARACTERISTICS & TREATED WATER PARAMETERS:-

   CLUSTER I/CLUSTER II

   Flow Rate : As per DBR or meeting functional requirements

1.1 DESIRED QUALITY AFTER TREATMENT

   a. DESIRED EFFLUENT QUALITY (AFTER TREATMENT):

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Parameter</th>
<th>Unit</th>
<th>Treated water</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td>-</td>
<td>6.5 - 8.5</td>
</tr>
<tr>
<td>2</td>
<td>Suspended solids</td>
<td>Mg/l</td>
<td>&lt; 100</td>
</tr>
<tr>
<td>3</td>
<td>BOD</td>
<td>Mg/l</td>
<td>&lt; 150</td>
</tr>
<tr>
<td>4</td>
<td>COD</td>
<td>Mg/l</td>
<td>&lt; 300</td>
</tr>
<tr>
<td>5</td>
<td>Oil &amp; Grease</td>
<td>Mg/l</td>
<td>&lt; 5</td>
</tr>
</tbody>
</table>

   b. DESIRED SEWAGE QUALITY (AFTER TREATMENT):

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Parameter</th>
<th>Unit</th>
<th>Treated water</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td>-</td>
<td>6.5 - 8.5</td>
</tr>
<tr>
<td>2</td>
<td>Suspended solids</td>
<td>Mg/l</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>3</td>
<td>BOD</td>
<td>Mg/l</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>4</td>
<td>COD</td>
<td>Mg/l</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>5</td>
<td>Oil &amp; Grease</td>
<td>Mg/l</td>
<td>Nil</td>
</tr>
</tbody>
</table>

   c. EXPECTED TREATED WATER CHARACTERISTICS AFTER FILTRATION AND SOFTENER (FOR COOLING TOWER MAKE-UP)

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Parameters</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td>6.0 - 7.0</td>
</tr>
<tr>
<td>2</td>
<td>Total Dissolved Solids</td>
<td>200 ppm</td>
</tr>
<tr>
<td>3</td>
<td>Suspended solids</td>
<td>&lt; 1 mg/ litre</td>
</tr>
</tbody>
</table>
Table Given above is Indicative & Treated Discharge Effluent/Sewage Water shall meet all relevant norms including BIS standards & GRIHA compliances.

2. TECHNICAL EQUIPMENT SPECIFICATIONS

i. PRIMARY TREATMENT
   a. SCREENS
      Quantity : 2 Nos. or as required
      Dimension : Wide: 600mm X Height: 1200mm
      MOC : Stainless Steel
      Type : Perforated
      Screening Size : 20mm & 10mm
      Lifting Arrangement : Yes

   ii. PUMPSET
      a. RAW SEWAGE TRANSFER PUMPSET (Collection Tank to Aeration Tank)
         Quantity : 3 Nos. (2W + 1S) or as required
         Type : Submersible, Vertical
         MOC of Body / Impeller : CI / Bronze
         Capacity : As Required
         Head : As Required
         Solid Handling Capacity : As Required
         Motor Rating : As required fulfilling technical parameters
         Lifting Arrangement : Manual MSEP

      b. PLANT ROOM SUMP PUMPSET
         Quantity : 2 Nos. (1W + 1S) or as required
         Type : Submersible, Vertical
         MOC of Body / Impeller : CI / Bronze
         Capacity : As Required
         Head : As Required
         Solid Handling Capacity : As Required
         Motor Rating : As required fulfilling technical parameters
         Lifting Arrangement : Manual MSEP

      c. LUDGE TRANSFER / RECIRCULATION PUMPSET
         Quantity : 3 Nos. (2W + 1S) or as required
Type : Monoblock. Centrifugal
MOC of Body / Impeller : CI / Bronze
Capacity : As Required
Head : As Required
Solid Handling Capacity : As Required
Motor Rating : As required fulfilling technical parameters

Providing, installation, testing & commissioning of screw Sludge disposal pump for the disposal of sludge to tanker or to sludge dry beds. The pumps shall have CI casing, bronze impeller & SS shaft & sleeve with mechanical rotary shaft seal connected by a flexible tier type coupling to TEFC induction motor mounted on a common channel baseplate with coupling guard, 150 mm dia pressure gauge with GM isolation cock, suitable vibration eliminator pads of approved design. Motor to be suitable for including all necessary piping, valves and other accessories and concrete foundation complete as required. (2 Working + 1 Stand-by or as required).

d. SLUDGE DISPOSAL PUMP PUMPSET

Quantity : 1 Set (2W+1S) or as required
Type : Screw, Horizontal
MOC of Body / Impeller : CI / Bronze
Drive : V – Belt
Direction of Rotation : Clockwise
Capacity : As Required
Head : As Required
Solid Handling Capacity : Sludge - STP
Motor Rating : As required fulfilling technical parameters

e. FILTER FEED PUMPSET

Quantity : 2 Nos. (1W + 1S) or as required
Type : Monoblock. Centrifugal with Mech. Seal
MOC of Body / Impeller : CI / Bronze
Capacity : As Required
Head : As Required
Solid Handling Capacity : As Required
Motor Rating : As required fulfilling technical parameters

iii. AIR DIFFUSION SYSTEM

a. AIR BLOWER

Quantity : 3Nos. (2W + 1S) or as required
Type : Twin Type Rotary
MOC of Body : Cast Iron
Drive : V – Belt
Direction of Rotation : Clockwise
Suction Silencer with Air Filter: Yes
Pressure Gauge / Relief Valve: 1 Each
Capacity : As Required
Discharge Pressure : As Required
Motor Rating : As required fulfilling technical parameters

b. AIR DIFFUSER
Type : Fine Bubble Tube Aerator
Air Transfer Capacity : 3 – 5cfm or as required
Length of Diffuser : 1000mm or as required
Dia. of Diffuser : 63mm or as required
Connection Size : 20mm or as required
MOC of Membrane : High Grade EPDM or as required
MOC of Pipe Support : SS / EPDM or as required
Fitting Material : PVC Shaddle

iv. MEDIA
a. FLUIDISED MEDIA (FOR AERATION TANK)
Quantity : As Required or required quantity as per capacity of STP selected
Type : Random Bio Media
MOC of Media : Virgin PP with UV Stabilized
Specific Surface Area of Media : 160.0 SQM/ CUM or as required
Protected Surface Area of Media : 102.4 SQM/ CUM or as required

b. TUBE PAC MEDIA (FOR TUBE SETTLER)
Quantity : Required Qty. to meet functional parameters
Type : Hexagonal Chevron Shape Self Supporting
MOC of Media : Virgin PVC, UV Stabilized

v. TERTIARY TREATMENT (AS PER REQUIREMENTS)
a. DUAL MEDIA FILTER
Quantity : 1 No or as required
Capacity : As Required
Working Pressure : 3.0kg/cm2 or as required
Type : Down Flow
MOC of Vessel : MS IS – 226 Duly Painted
Thickness of Shell / Dish : 8 / 10mm or as required
Thickness of Dish Plate : 6mm or as required
### Diameter
- 1750mm or as required

### Height of Straight
- 1500mm or as required

### Distribution System
- Dish Plate with PVC Nozzles

### Controls
- Frontal Piping with Butterfly Valves

### Frontal Piping
- MS Welded

### Manhole / Handhold Cover
- 1 Each

### Air / Drain Valve
- 1 Each

### Pressure Gauge / Sampling Cock
- 1 Each

**Filter Media**

River mesh sand supported coarse sand and fine sand.

### b. ACTIVATED CARBON FILTER

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quantity</strong></td>
<td>1 No. or as required</td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
<td>As Required</td>
</tr>
<tr>
<td><strong>Working Pressure</strong></td>
<td>3.0kg/cm² or as required</td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td>Down Flow</td>
</tr>
<tr>
<td><strong>MOC of Vessel</strong></td>
<td>MS IS – 226 Duly Painted</td>
</tr>
<tr>
<td><strong>Thickness of Shell / Dish</strong></td>
<td>8 / 10mm or as required</td>
</tr>
<tr>
<td><strong>Thickness of Dish Plate</strong></td>
<td>6mm or as required</td>
</tr>
<tr>
<td><strong>Diameter</strong></td>
<td>1750mm or as required</td>
</tr>
<tr>
<td><strong>Height of Straight</strong></td>
<td>1500mm or as required</td>
</tr>
<tr>
<td><strong>Distribution System</strong></td>
<td>Dish Plate with PVC Nozzles</td>
</tr>
<tr>
<td><strong>Controls</strong></td>
<td>Frontal Piping with Butterfly Valves</td>
</tr>
<tr>
<td><strong>Frontal Piping</strong></td>
<td>MS Welded</td>
</tr>
<tr>
<td><strong>Manhole / Handhold Cover</strong></td>
<td>1 Each</td>
</tr>
<tr>
<td><strong>Air / Drain Valve</strong></td>
<td>1 Each</td>
</tr>
<tr>
<td><strong>Pressure Gauge / Sampling Cock</strong></td>
<td>1 Each</td>
</tr>
</tbody>
</table>

**Filter Media**

River mesh sand supported coarse sand and Granular Activated Carbon 1000IV.

### c. ULTRA VIOLET UNIT (AS PER REQUIREMENTS)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quantity</strong></td>
<td>2 No. or as required</td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
<td>As per Requirements</td>
</tr>
<tr>
<td><strong>MOC Reactor</strong></td>
<td>Stainless Steel 316L</td>
</tr>
<tr>
<td><strong>MOC Quartz Jacket</strong></td>
<td>High Purity Quartz (UVT &gt; 95%)</td>
</tr>
<tr>
<td><strong>UV Dosage</strong></td>
<td>60mJ/cm² (65% UVT)</td>
</tr>
<tr>
<td><strong>Voltage</strong></td>
<td>220 – 240V / 50 – 60Hz</td>
</tr>
<tr>
<td><strong>End Connection</strong></td>
<td>65mm or as required</td>
</tr>
<tr>
<td><strong>Max. Operating Pressure</strong></td>
<td>80psig or as required</td>
</tr>
</tbody>
</table>
Max. Operating Temperature : 45 Degree C
Control Panel Rating : IP54
Control Panel MOC : Sheet Steel with Electrophoretic Dipcoat
Primings and Textured Powder
Coating Ballast Type : Electronic with Programmed Soft Start
Lamp Replacement Reminder : Yes
Lamp Running Hour Counter : Yes
Lamp Failure Indication : Yes
UV Monitoring System : Yes

vi. SLUDGE DEWATERING

a. FILTER PRESS

Quantity : 1 No.
Type : Hydraulic
Type of Element : P.P. Recess
Type of Delivery : Slide & Open
Closing Device : Motorized
Drainage Surface : Pips
Plate Size : 300 X 300 (mm)
No of Recess Chamber : 18 Nos.
Operating Pressure : 3 – 5 Kg/Cm2
Max. Operating Temp. : 80 Deg. C
Filter Cloth : 1 Set

vii. INSTRUMENTATION

a. LEVEL INDICATOR & CONTROLLER

Quantity : 2 Set or as required
Dimension : As Required within CCT & FWT
Type : Electronic
High / Low level Alarm : Yes Auxiliary NO/NC

b. AIR FLOW METER

Quantity : 2 Nos.
Type : Vertical - Rotameter
MOC of Body : High Grade Acrylic
Capacity : 20M3/Hr.
Operating Temperature : Ambient
Operating Pressure : 6PSI
MOC of Float : SS 316
c. WATER FLOW METER

<table>
<thead>
<tr>
<th>Quantity       :</th>
<th>1 No. or as required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type           :</td>
<td>Electromagnetic</td>
</tr>
<tr>
<td>Capacity       :</td>
<td>15M3/Hr. or as required</td>
</tr>
<tr>
<td>Operating Temperature :</td>
<td>Ambient</td>
</tr>
<tr>
<td>Operating Pressure  :</td>
<td>6PSI or as required</td>
</tr>
<tr>
<td>Connection Size  :</td>
<td>50mm or as required</td>
</tr>
<tr>
<td>MOC of Connection :</td>
<td>SS</td>
</tr>
</tbody>
</table>

d. pH METER

<table>
<thead>
<tr>
<th>Quantity       :</th>
<th>1 No. or as required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type           :</td>
<td>Flow Through / Tank (Optional)</td>
</tr>
<tr>
<td>Sensor O/P      :</td>
<td>Milli Volt</td>
</tr>
<tr>
<td>Application / Fluid  :</td>
<td>Treated Sewage</td>
</tr>
<tr>
<td>Range           :</td>
<td>00.00 – 14.00 pH</td>
</tr>
</tbody>
</table>

e. ENERGY METER

<table>
<thead>
<tr>
<th>Quantity       :</th>
<th>1 No. or as required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type           :</td>
<td>Electronic</td>
</tr>
<tr>
<td>Range           :</td>
<td>10 – 40 Amps.</td>
</tr>
</tbody>
</table>

vi. INTERCONNECTING PIPE & FITTINGS

a. PIPING

| Submerged Air Pipe Line  : | SS 304        |
| Diffuser Line            : | Flexible      |
| Air Line                 : | MS Epoxy Painted |
| Effluent & Submerged Water Pipe Line : | PVC Heavy Class |
| Water Line               : | MS Duly Painted |
| Pipe Class               : | Medium Class   |
| MOC of Fittings          : | As Required    |

ix. ELECTRICAL WORK

a. ELECTRICAL CONTROL PANEL

<table>
<thead>
<tr>
<th>Quantity       :</th>
<th>1 Set or as required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fabrication Material :</td>
<td>14Gauge CRCA Sheet Steel duly</td>
</tr>
<tr>
<td>Anticorrosive Paint &amp; Powder Coated Gland Plate: Top &amp; Bottom</td>
<td></td>
</tr>
<tr>
<td>Description     :</td>
<td>As required</td>
</tr>
<tr>
<td>Electrical Accessories :</td>
<td>ISI Approved</td>
</tr>
</tbody>
</table>

b. CABLE & CONDUITING

<table>
<thead>
<tr>
<th>Quantity       :</th>
<th>1 Lot within Plant Room</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type           :</td>
<td>Flexible – Triple Layer ISI Marked</td>
</tr>
</tbody>
</table>
B. EFFLUENT TREATMENT PLANT:

Design, Engineering Supply, Installation, Testing & Commissioning of ETP shall be carried out by the Contractor on EPC Basis & as directed by Engineer-in-charge.

The specifications for ETP Capacity shall be as defined in Design Basis Report, meeting functional requirements & 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.

The ETP shall be of compact type & housed in common pump room of STP for Cluster 1. The ETP shall be constructed with MS (FRP) coated with min. 3 mm. The ETP shall be designed as water retaining structures, with necessary chemical dosing as required by the manufacturer’s design. All the Equipment, piping, pumps, air blowers & electrical panel shall be housed in the ETP skid including MS puddle flange (galvanized), inlet, outlet, overflow, vent, moving ladders & railing. The plant shall be complete with a central electric panel fully pre/site wired & with all power & control cables to all pumps & equipments including all instrumentation, level & other controllers.

ETP shall be complete with SS perforated basket screen with chain lifting arrangement, Flash Mixer, Flocculator, tube Settler, media inside tube settler, lime/alum/polyelectrolyte dosing system with HDPE tank & pumping system, all valves, strainers, pressure gauges, air blower, agitator & all required pumps.

PVC pipes (10 kg/sqcm) - For all submerged waste water piping, MS (C class) - For all exposed air piping & flexible stainless steel pipe for submerged air pipe, GI (C class) - for all other water piping shall be used in ETP.

Approval of Technical datasheet & Shop drawings for ETP shall be sought from Contractor before commencement of work.

C. SOLAR WATER HEATING SYSTEM

Design, Engineering Supply, Installation, Testing & Commissioning of Solar Water Heating system shall be carried out by the Contractor on EPC Basis & as directed by Engineer-in-charge. Solar Hot water system shall include flat plate solar collector panels as per OEM standards, absorber coating shall be suitably selected, coating absorptivity should be greater than 90% & coating emmisivity should be less than 20% with fins, laser/ultrasonic welded with brass flanges & EPDM rubber gaskets. Absorber will be Cu-Cu type of suitable dimensions. It shall be provided with rockwool or any other suitable insulation at sides & bottom of suitable thickness, density & K value. Make up water tank of suitable capacity shall be of PVC construction & shall be provided with soft water provision & to refill at particular interval.

For Hospital Building Close Coupled Solar Hot Water System coupled with Heat Pumps shall be used. In a "close-coupled" SWH system the storage tank is horizontally mounted immediately above the solar collectors on the roof. No pumping is required as the hot water naturally rises into the tank through thermostiffon flow. Solar water heating system produces hot water at a temperature of 60 Deg. C and in accordance with the IS-12976:1990 and IS-12933:1990 (Part 1 to part 5). Solar hot water system may be with recirculation pump & heat exchanger system, pump to supply water from raw water storage tank to solar storage tank if height of storage tank is higher than raw water storage tank. Heat bank of suitable capacity & MOC of MS with special resin bonded
FRP lining of required shell & dish thickness. It shall be provided with suitable insulation of required thickness, K value & density.

Plate type heat exchangers shall be made of SS 316 plates of suitable capacity with primary & secondary pumps which shall be horizontal centrifugal type of suitable head & discharge with motor conforming to IE3 class efficiency with brass impeller, SS 304 shaft & CI casing. Mixing Tank of suitable capacity made of SS 304 with quartz coating & insulation of suitable thickness of required K value, density & 24 G Aluminium cladding.

Electrical heater back up & recirculation centrifugal pumps of suitable capacity with primary & secondary pumps which shall be horizontal centrifugal type of suitable head & discharge with motor conforming to IE3 class efficiency with brass impeller, SS 304 shaft & CI casing. Cold water tank for providing water a solar mixing tank of suitable capacity made out of PVC with low & high level controllers. Electrical control panel for the entire system with necessary cabling, level controllers, sensors, wires & other accessories shall be provided.

System to ensure that the solar hot water generated during the sunshine hours of the day is stored in a Solar Insulated tank (Heat Bank) & then the heat is transferred to the Mixing tank as & when required (HTC application), so that the Hot Water is made available at the Controlled Temperature for final usage.

In other buildings, conventional Solar Hot Water System shall be used with/without any recirculation pumps. It supplies the hot water by gravity as a preheated water to the electric geysers at all user points. Wherever, pumps are provide, one standby provision to be considered.

**TESTING:** All G.I pipes of Primary Circuit (Collector Circuits) shall be tested to hydrostatically for a period of 30 minutes to a pressure of 2 kg/Sq.cm without drop in pressure and all other G.I pipes for a pressure of 6 Kg/Sq.cm.

**HOT WATER STORAGE TANK**

SS-304 horizontal/vertical hot water storage tank with the required thickness (as Required) to withstand working pressure of 5 kg/sqcm. The hot water storage tank is provided with a manhole, cover, drain, vent, overflow, inlet and outlet connections etc as required and as per direction of Engineer in Charge.

Each hot water storage tank shall be provided with the following:

- Thermostatic control valve
- Safety valve
- One Air Release valve
- Pressure and temperature relief valve
- High limit Temperature sensor
- Primary flow connection
- Hot water supply connection
- Hot water return connection
- Drain connection
- Thermometer fitted (inserted) in thermo well
- Pressure gauge
- Make up tank
- Ball valve

The hot water storage tank shall be hydrostatically tested to one and half times the working pressure of a system for a period of 24 hours without any leak. Field tests are to be performed at site to satisfy the capacity and operation of the unit by the CLIENT/HITES/project in-charge.

**PIPING**

**a. HOT WATER PIPING**

Supply and return pipes of the hot water system complete with necessary pipes, bends, flanges, fittings, gaskets and valves are to be provided to connect Solar water heating system, hot water storage tank.

The hot water supply and return pipes are insulated with Rock wool and cladded with aluminium sheets of 24SWG.

**b. HOT WATER SOLAR PIPING**

GI/CPVC/UPVC solar hot water piping complete with bends, flanges, fittings, gaskets and valves to connect the solar panels to the hot water storage tank with necessary valves and fittings.

This also includes the solar circulation pumps as per requirement to circulate the hot water to the tank from the solar panels.

The hot water piping insulated with Rock wool and cladded with aluminium sheets.

**c. PIPE INSULATION**

Pipe insulation shall be as required under “HOT INSULATION”.

**d. INSTALLATION**

Pipe installation shall be carried out with proper workmanship in accordance with approved drawings/Engineer in Charge. Pipe shall be aligned parallel to walls and ceiling and not across the room. Change of direction shall be through hydraulically formed welding fittings as specified.

Alignment shall follow the approved drawings/Engineer in Charge and wherever necessary pipe shall be rerouted under the instructions of Engineer in Charge in order to meet the site conditions and or interference from other services.

**e. PAINTING**

Pipe supports shall be of steel with a prime coat of red oxide and two finish coats of matt black paint after installation. Supports shall be spaced as follows:

<table>
<thead>
<tr>
<th>Size</th>
<th>Horizontal</th>
<th>Vertical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 15 mm</td>
<td>1.25 m</td>
<td>1.8 m</td>
</tr>
<tr>
<td>20 to 25 mm</td>
<td>2.00 m</td>
<td>2.5 m</td>
</tr>
<tr>
<td>32 to 125 mm</td>
<td>2.50 m</td>
<td>3.0 m</td>
</tr>
<tr>
<td>150mm &amp; Over</td>
<td>3.00 m</td>
<td>3.0 m</td>
</tr>
</tbody>
</table>
f. SUPPORTS

- Additional supports shall be provided at the bends, at heavy fittings like valves, near equipment and as directed by Engineer in Charge. Pipe hangers shall be from structural steel, steel inserts in concrete, wall brackets or floor supports as decided by the Engineer in Charge depending upon the location of the support. Hangers shall not be secured to light weight roof, wall, false ceiling or any other member which is not structurally meant for such loading. Hangers from structural steel shall be from suitably designed clamps or attachments and in no case should drilling or punching of such steel members be allowed. All pipe supports shall be capable of being adjusted in height to the tune of 50 mm.

- Pipe clamps shall be specially fabricated fittings for pipes. All clamps shall be of galvanized steel and finish coated with matt black paint. Clamps shall take into account pipe movement owing to temperature variations & anchors, and in no case shall the clamping arrangement induce stresses beyond the safe load limits of the pipe under fully filled conditions. Where pipes are insulated, the clamping shall interpose a hard insulation material or shall be designed so that the insulation is not compressed for more than 60 % of its compression strength.

- Vertical pipe risers shall be supported at each floor and in addition, the riser shall have a duck-foot support.

- All pipe joints shall be welded except where flange joints are specified hereinafter. Pipes upto 40 mm NB shall use socket - weld fittings of 150 lbs rating with fillet welding and larger sizes shall used with butt-welding type single V 35 deg weld preparation. Flange joints shall be provided at the following positions:
  
a. Pair of flanges for isolation of equipment

b. Mating flange for equipment flange connections

c. Mating flange for valves, strainers as the case may be

d. Pair of flanges at every 40 m continuous run of piping

e. All piping shall be laid and tack welded in position with flanges, valves etc. After inspection and approval by the Engineer in Charge as to the alignment and height, the piping shall be full welded. Piping may be presented for such approval in sections. Slip-on flanges shall be demounted for welding. Random samples of valves shall be tested for leaks and seating. Necessary hand pump and blank flange facilities with pressure gauge, valves etc. should be provided at site.

f. All pipe insulations shall be carried out in sections after duly testing.

g. TESTING

Piping shall be hydrostatically tested to 1.5 times more than the rated pressure for a minimum period of 24 hours without any leak and loss of pressure.

D. SOLAR COLLECTOR PANELS

1. The scope of work covers supply, erection, testing and commissioning of the Solar Collector Panels meeting the requirements and the intent of this specifications.

2. Manufacturer’s catalogues and guaranteed performance details to be submitted for Approvals before ordering the supply of the equipment.

a. COLLECTOR:
Type: copper type with minimum size of 2 sqm of each type.

- Collector Frame Extruded - Aluminum 1.4 mm thick or as required
- Gasket for Glass (Beading) - EPDM "U" Type
- Glazing (Cover) - Toughened clear glass
- Collector Body - Aluminum
- Bottom Insulation - 40 mm Rockwool (Minimum)
- Side Insulation - 20 mm Rockwool (Minimum)
- Absorber Plate - Copper
- Riser Copper - Dia- 12.7 mm or as required
- Inlet Header Copper - Dia- 25.4 mm or as required
- Reflective Foil - Aluminum or as required
- Grommet - EPDM or as required
- Collector Back sheet - Aluminum or as required
- Absorber area - 2 Sq. Mtr. or as required
- No. of Riser tubes per collector - 9 per collector
- No. of Absorber Plate per collector - 9 per collector
- Glazing transmissivity - > 80%
- Coating absorptivity - > 0.90
- Coating emissivity - < 0.20
- Absorber riser bonding - Ultrasonic/Laser Welding
- Collector efficiency at ambient temp. - > 65% or as required
- Finish - (Powder Coating) Golden yellow for frame, Black for Glass retaining angle
- Working Pressure - 5 Kg/cm² or as required
- Operating Conditions T > 50deg.C or as required

b. COLLECTOR SUPPORT FRAME

The structure should be in a position to withstand a wind velocity of 100 Kms/hr. It shall be made of angle iron 40mm x40mmx5mm and shall have vertical support at top and bottom edge of the inclined plane of the collector at a distance of 2.5 m or less. The vertical support shall be firmly grouted to the roof in the ground in case of ground mounted system. The grouting blocks shall be of minimum equal to 250 mm x 250 mm x 150 mm and finished properly. In case the grouting is carried out on roof already water proofed with asphalt the back support of the collectors may be anchored to the parapet or the size of the grouting block shall be increased to provide for a dead weight anchoring of 75 kg per leg of the vertical support. Any other alternative method of grouting/supporting shall be submitted the documents to Engineer-In-Charge / Project In charge for their approval prior to execution.
c. ABSORBER

(1) The absorber shall consist of riser, header and sheet for absorber. The diameter of header shall be 25.4 mm and thickness 0.71 mm. The diameter of the riser shall be 12.7 mm and thickness 0.56 mm and made of copper only. The distance between the riser from centre to centre shall be 120 mm. Type, Grade, Size, Workmanship and Finishes shall be as per IS: 12933. The riser and header pipes shall be of copper. The welding between Copper tube riser and Copper Sheet should be Laser-Welding or Ultrasonic-Welding.

(2) The sheet shall be coated with selective coating to satisfy solar absorption of more than 0.90 & solaremissivity < 0.12. or as required.

(3) The selective coating shall not get damage when the sample is raised to 1250 Degree C temperatures.

(4) All tests such as solar absorption test, emissivity test and temperature tests are to be carried out as per standard tests.

(5) Riser and header assembly designed for working pressure up to 2.5 Kg/cm² and shall be tested for leakage at the Min. hydraulic pressure of 3.5 kg/cm².

(6) Sheet for absorber shall be made of copper only.

d. STAND

The stand for the collector and hot water storage tank are to be designed taking into consideration the load to be carried by the stand. The collector becomes vulnerable to wind dust. The collector may be up-listed by wind striking the underside. This wind load should be determined according to accepted engineering practices and procedures. The material for collector stand shall be of size 32 x 32 x 3 mm M.S. Angle iron with one coat of red oxide primer and two or more coats of enamel paint.

e. SOLAR HEAT BANK TANK

The material of the Solar Heat Bank shall be MS Sheet. & capacity shall be 10,000 Liters. The thickness of the Solar Heat Bank Tank shall be 6 mm shell and 8 mm dish ends. The tank shall have a Manhole of dia. min. 450mm & have a special layer of Resin Bonded Fiberglass Coating inside the tank to prevent corrosion. The tank shall be semi-pressurized type with air vents.

f. SOLAR MIXING TANK

The material of the Solar Mixing Tank shall be SS-304 Sheet. & capacity shall be as per requirements. The thickness of the Mixing Tank shall be 3mm shell and 4 mm dish ends. A special layer of QUARTZ coating inside the tank to prevent corrosion shall be provided. The tank shall be non-pressurized type with air vents.

g. TANK INSULATION

Both the Hot Water Tanks shall be insulated with 100 mm thick rock/glass wool of 48 Kg/m³ of density & clad with 24 SWG Aluminium cladding.

h. PLATE HEAT EXCHANGER

The Plate Heat Exchanger for Heat Transfer & Control (HTC) application shall be made of SS-316 plates. The capacity for heat transfer should be as per requirements.

i. SYSTEM INTERCONNECTING PIPING

G.I. Pipe of Medium class as per IS: 1239 duly insulated with 13mm Nitrile Tube & clad with polysheild outer mechanical protection on nitrile rubber insulation, comprising of wrapping with
poly-glass tape helically wound and subsequently applying 2 coats of polyshield material(resin & hardener) as per manufacturer specification and approved by Engineer-in-charge.

j. MAKEUP TANK

The capacity of Makeup tank for solar circuit shall be 200 Ltr. or as required complete with float valve and interconnection piping as required. Soft water is to be provided for the makeup tank by client.

k. ELECTRICAL HEATER

Electrical Heater shall be ISI Marked. Electrical heater shall be of 12 nos. each of rating 5 KW for the 5000 Liter Mixing Tank or as required.

l. ELECTRICAL HEATER CONTROL PANEL

The Electrical Heater System shall be split in 2 zones of 30KW each or as required & shall be having Thermo-Sensor based operation. Electric Heater Control Panel of total 60kW rating shall be part of the main Control Panel as the Heater Control Zone.

m. PUMPS FOR FORCED CIRCULATION, HTC & RE_CIRCULATION OPERATIONS

All Pumps used in the solar system for Forced Circulation, HTC & Re-Circulation Systems shall be Horizontal type with Centrifugal operation & having SS Impeller & Shaft and with CI Body. All Pumps shall be suitable for 3-Phase Operation & shall be for 1 Working & 1 Standby mode.

n. CONTROL PANEL FOR PUMP OPERATION

The Operation of the Pumps in the above operations shall be DOL Starter based with adequate rating. The Main Control Panel Shall be sub-divided into sub-Zones for foll. Operations

- Forced Circulation Zone
- Heat Transfer & Control Zone (for Primary & Secondary Pump sets)
- Hot Water Re-Circulation in Building Zone

Note: Contractor shall provide Control Panel with makes as specified in the list of approved makes with digital differential temperature controller / PLC including necessary electronic parts like Contractors, Relays, Indicators, MCBs, Control fuses etc. for satisfactory working of pumps.

o. TEMPERATURE GAUGE

DIAL Type temperature gauge duly calibrated and suitable for temperature range 0-120 deg. Celsius shall be provided.

Contractor shall provide all valves, strainer, float valves and NRV etc. as per requirement.

Contractor shall provide 1:2:4 cement concrete foundation of size 300x300x250 mm (1 cement: 2 coarse sand: 4 stone aggregate of size 20 mm nominal size) for each and every footing of system. This will be scope of Civil Contractor with complete guidance from Solar Contractor.

p. PAINTING OF STANDS

Proper cleaning and degreasing of the surface should be done before painting. Two coats of zinc chromate red oxide primer shall be applied followed by one coat of epoxy paint and approved colour recommended by the CLIENT/ HITES.
q. PIPING

a) Material : Medium class (B class) GI as per IS 1239 shall be used for piping.

b) Back insulation : Insulation of R value = 1.67 m2 °C/W to withstand a temperature of 100°C shall be used.

Typical insulation detail shown below and also conforming to ECBC standards.

Thin plastic sheet shall be used as covering between glass wool and aluminum cladding besides other retaining material like chicken mesh etc.

24 SWG aluminium sheet shall be used for cladding the insulated pipe.

r. VALVES / NIPPLE / TEES / BENDS

Gun metal valve as per IS 780 specifications shall be used.

Nipple / Tees and bends shall be of GI as per IS 1239 Part II.

Gun metal ball valve shall be provided in each row outlet with Air vent.

s. VALVES

Gate valves or butterfly valves for shut-off or sectionalizing service, globe or ball valves for flow modulation. For on-site control, use gate valves. Specialty valve shall be employed where appropriate, such as check valves on a pump discharge, pressure regulating valves for equipment requiring lower-than-available system pressure, solenoid valves, etc. Flanged or threaded end valves are preferred. Locate valves in accessible locations, not more than six feet above the floor, if frequently used, and with a union on the downstream side of threaded end valves.

Provide each valve with brass, aluminum or plastic disc not less than 32mm diameter engraved with numbers, piping service and normal operating position (i.e. NO, NC) corresponding to valves shown on the diagram. Fasten disc to valve with 14gauge brass wire or 16gauge jack chain.

t. GATE VALVE

The primary function of a gate valve is for starting and stopping of flow. It has a disc actuated by a stem screw and hand wheel, moves up and down at right angles to the path of flow of fluid and seats against two faces to shut of flow. As the disc of the gate valve presents a flat surface to the direction of flow, this valve is only for starting and shutting the flow in the pipe.

These valves are of Gun Metal (GM) make. Supplying, fixing and testing correspond to IS 778-1984, Specifications for Copper Alloy Gate, Globe and Check Valves for Water Works.

All globe and check valves shall have working parts suitable for hot and cold water, as required. Valves shall be tagged with permanent label under hand wheel indicating type or duty.

All valves should have manufacturer’s test certificate indicating the date of shop test and other quality control tests with the material used for the same.

u. BALL VALVE

The ball valve shall be of high-pressure type and shall be of sizes as specified and/or shown in the drawings the normal size of a ball valve shall be that, corresponding to the size of the pipe to which it is fixed. Ball valves shall have body of carbon steel. The ball and the shaft shall be of stainless steel. The seat shall be of PTFE.
The valve shall be complete with socket weld ends and the float of copper sheet. The minimum thickness of copper sheet used for making the float shall be 0.45mm for a float exceeding 115mm dia. The body of the high-pressure ball valve when assembled in working condition with the float immersed to not more than half of its diameter shall remain closed against a test pressure of 3.5kg/sqcm.

The ball valve shall generally conform to IS specification No.1703: 1977. The weight of ball cock and the size of the ball cock shall be as per IS specification.

v. SYSTEM LAYOUT AND DESIGN

Maximum number of collector in series shall be not more than Ten for Thermosyphon system and not more than 15 for force circulation system.

Maximum number of collector in parallel in one row with header to header connections should not be more than Six.

Air venting at appropriate places without hindrance of a spring loaded valve to prevent air locking in the system should be provided. For this purpose system shall have at a suitable point atmospheric pressure conditions preferably in the high temperature zone. Flow rates commensurate with optimum heat removal from collector plates.

System shall have a suitable expansion / make up tank at a high point in the system to ensure that collectors run full all the times. Capacity of this expansion make up tank should be 1% of the system capacity.

For all systems above the capacity of 5000 LPD and 1.5% of the system capacity for the systems of capacity ranging from 1000 LPD to 5000 LPD.

Expansion cum make-up tank is for closed loop system and make up tank is for open loop system.

E. HEAT PUMPS

The Packaged type Air to Water Heat Pump. shall be completely factory assembled including required Nos. of Scroll Hermetically Sealed Scroll / Reciprocating Compressor(s), evaporator, Condenser and Microprocessor Control Panel etc with R134a / 410 a/ 470 c or any other CFC free Referigerant and COP between 3-4.

The Heat Pump shall have inbuilt hot water heat exchanger, vibration isolators, pumps, valves, expansion valve, Copper / Aluminium fins, and other accessories. The Heat Pump should be capable of producing hot water at minimum 55°C temperament at outlet (condenser circuit) temperatures at approx. 40°C ∆T. The Machine should have an operating ambient temperature range of 0°C to 40°C.

Heat Pump shall have built in electric panel as per safety norms as manufacturer standard. It shall be Suitable for electric supply of 415 + 10% volts & 50 Hz. The Heat pump shall have an in-built facility to start / stop depending on variation in demand at different periods. All interconnecting wiring / cabling between heat pump and electrical panel shall be part of the equipment. The heat pump should be designed at ambient temperature at 7 degree celcius considering de-aeration of Equipment.

SS 304 horizontal hot water storage tank of required capacity suitable for minimum 7 kg/sqcm operating pressure. Tank shall be provided with hot water flow meter at inlet & outlet, inlet/outlet, overflow/drain connections with MH cover, pressure relieve valve, pressure gauge at inlet/outlet with isolation cock & thermometer. Tank shall be provided with 24 G aluminium cladding. It shall eb provided with 15 mm dia. testing spout with valve. The Heat Pumps shall be installed in N+1 condition at terrace level of hospital building.
**Testing, Commissioning & Operation:** After satisfactory installation of all the systems, entire system shall be tested, commissioned as per procedure laid down & operated for continuous 30 days as directed by E-I-C.
CHAPTER-P

TECHNICAL SPECIFICATIONS- RO PLANT (Portable & Centralized)

1. SCOPE OF WORK:

Work shall consist of furnishing all labour, materials, equipment, 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 DBR and/or shown on the plumbing drawings for RO Plant.

1.1. EXECUTION OF WORK

1.1.1. The Contractor should visit and examine the site of work and satisfy himself as to the nature of the existing roads and other means of communication and other details pertaining to the work and local conditions and facilities for obtaining his own information on all matters affecting the execution of work.

1.1.2. The work shall be carried out in conformity with the Plumbing drawings and within the requirements of architectural and coordinated with all services drawings.

1.1.3. The Contractor shall cooperate with all trades and agencies working on the site. He shall make provision for hangers, sleeves, structural openings and other requirements well in advance to prevent hold up of progress of the construction schedule. All supports to the civil structure shall be provided with dash fasteners.

1.1.4. On award of the work, Contractor shall submit a schedule of construction in the form of a PERT chart or BAR chart for approval of the Engineer-In-Charge/ CLIENT. All dates and time schedule agreed upon shall be strictly adhered to within the stipulated time of completion/commissioning along with the specified phasing, if any.
1.1. DRAWINGS

1.1.1. Shop drawings will be prepared & submitted to Engineer-in-charge for approval. The execution of work shall be done in-line with the approved shop drawings.

1.1.2. Architectural drawings shall take precedence over plumbing or other services drawings as to all dimensions.

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

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

1.1.5. Any drawings issued by the Engineer-in-charge for the work are the property of the Engineer-in-charge and shall not be lent, reproduced or used on any works other than intended without the written permission of the Engineer-in-charge.

1.2. REFERENCE DRAWINGS

1.2.1. The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on site. All important drawings shall be mounted on boards and placed in racks indexed. No drawings shall be rolled.

1.2.2. All corrections, deviations and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings to be submitted by the contractor in fulfilment of the conditions of this contract.

1.2.3. On award of the work the contractor shall be issued, one set of CLIENT’s working drawings stamped “tender drawings” by the Engineer-In-Charge. The CLIENT’s drawings shall be the basis of contractor’s shop drawings. Upon submission of shop drawings to CLIENT, Final approved drawings will be stamped as “Good for Construction” drawings, based on which execution work will be done.

1.2.4. Shop drawings are detailed working drawings which incorporate the contractor’s details for execution of the work and incorporate equipment manufacturer’s details and dimensions to ensure that the same can be installed in the space provided.

1.2.5. All shop drawings should detailed pipe routing and levels, showing location of other services at crossings etc., cable runs, route cable trays and all allied works and must be fully coordinated with other services and approved by the Engineer-In-Charge before execution of the works.

1.2.6. Shop drawings shall be furnished for detailed layout of all equipment, foundation, bolting and vibration elimination details along with information on dead and dynamic load, vibration etc.

1.2.7. Two sets of manufacturer’s equipment drawings, roughing in and wiring diagrams shall be submitted.

1.2.8. Contractor shall submit shop drawings furnishing all details of MCC panels, cable routes, wiring diagrams and connection details as required.

1.2.9. Two copies of each set of shop drawings shall be submitted for initial scrutiny, discussion and approval.

1.2.10. Each submission shall be accompanied by contractor’s certificate stating that the shop drawings meet all the contract requirements and that the piping and equipment can be satisfactorily installed without any obstructions in the space available.

1.2.11. On approval of the above the contractor shall furnish three sets of the approved shop drawings for execution of the work.
1.3. INSPECTION AND TESTING OF MATERIALS

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

1.3.2. For examination and testing of materials and works at the site Contractor shall provide all testing and gauging equipment necessary but not limited to the following:
   a. Steel tapes
   b. Weighing machine
   c. Plumb bobs, spirit levels, hammer
   d. Micrometers

1.3.3. Hydraulic machine

1.3.4. All such equipment shall be tested for calibration at any approved laboratory, if required by the Engineer-In-Charge. All testing equipment shall be preferably located in special room meant for the purpose.

1.3.5. Samples of all materials shall be got approved before placing order and the approved samples shall be deposited with the Engineer-In-Charge.

1.4. METRIC CONVERSION

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

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

1.5. COMPLETION DRAWINGS

1.5.1. On completion of work, Contractor shall submit one complete set of original tracings and six prints of "as built" drawings. These drawings shall have the following information.

1.6. Run of all piping, diameters on all floors, vertical stacks and location of external services.

1.7. Ground and invert levels of all drainage pipes together with location of all manholes and connections up to outfall.

1.8. Run of all water supply lines with diameters, locations of control valves, access panels.

1.9. Layout showing location of all mechanical equipment and piping connections.

1.10. All shop drawings shall be updated from time to time for the purpose of making completion drawings.

1.11. No completion certificate shall be issued unless the above drawings are submitted.

1.12. Contractor shall provide four sets of catalogues, service/operation & maintenance manuals, manufacturer's drawings, performance data and list of spare parts together with the name and address of the manufacturer for all electrical and mechanical equipment provided by him.

1.13. All "warranty cards" given by the manufacturers shall be handed over to the Engineer-In-Charge.

1.14. TESTING

1.14.1. Piping and drainage works shall be tested as specified under the relevant clauses of the
1.14.2. Tests shall be performed in presence of the Engineer-In-Charge and test records for the tests shall be duly signed by Contractor and the Engineer-In-Charge.

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

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

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

1.15. SITE CLEARANCE AND CLEANUP

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

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

1.15.3. On completion of all works, Contractor shall demolish all stores, remove all surplus materials and leave the site in a broom clean condition, failing which the same shall be done by the Engineer-In-Charge at the Contractor’s risk and cost. Cost of the cleanup shall be deducted from the contractor's bills on pro-rata basis in proportion to his contract value.

1.16. LICENCE PERMITS AND AUTHORITIES

1.16.1. Contractor must hold a valid plumbing or any other as required license by the municipal authority or other competent authority under whose jurisdiction the work falls.

1.16.2. Contractor must keep constant liaison with the local development, municipal /statutory authority and obtain approval of all drainage, water supply, fire suppression and other works carried out by him.

1.16.3. Contractor shall obtain, from the municipal and other authorities 'C' & 'D' & other forms as required for approval of drainage and water supply works during execution and the completion certificate with respect to his work as required for occupation of the building. Contractor shall obtain permanent water supply and drainage connections from authorities concerned. CLIENT shall reimburse the fees paid to the authorities towards the connection charges on production of receipts for money paid.

1.16.4. Contractor shall get any materials tested from the appropriate authority if so required with no cost to the CLIENT.

1.17. CUTTING OF WATER PROOFING MEMBRANE:

1.17.1. No walls terraces shall be cut for making and opening after water proofing has been done without written approval of Engineer-In-Charge. Cutting of water proofing membrane shall be done very carefully so as other portion of water proofing is not damaged. On completion of work at such place the water proofing membrane shall be made good and ensured that the opening/cutting is made fully water proof as per specifications and details of water proofing approved by Engineer-In-Charges.

1.18. MATERIALS

1.18.1. Unless otherwise specified and expressly approved in writing by the Engineer-In-Charge, only materials of makes and specification as mentioned in the list of approved makes
attached with the specifications shall be used.

1.18.2. If required, the Contractor shall submit samples of materials proposed to be used in the works. Approved samples shall be kept in the office of the Engineer-In-Charge.

2. DESIGN BASIS:-

The central RO Capacity shall be of minimum 5000 LPH capacity for Hospital. Building. In all other areas portable RO Water System with SS water cooler shall be installed as per DBR & meeting functional requirements.

2.1. TREATED WATER QUALITY

Physical Quality

Normally the RO water turbidity shall be less than 1 NTU.

The colour of the filtered water shall be restricted to 2 Hazen units on platinum cobalt

There shall be nothing objectionable as regards taste and odor

Chemical Quality

The pH value of filtered water shall be within 6.5 – 7.0

Other chemical quality parameters such as total dissolved solids should be less than 50 ppm

Biological Quality

Throughout the year, 100% of samples shall not contain any coliform organism in 100 ml.

Coliform organisms shall not be detectable in 100 ml of any two consecutive samples. No sample shall contain E – Coli in 100 ml.

EXPECTED TREATED WATER CHARACTERISTICS AFTER RO (REVERSE OSMOSIS PLANT)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH</td>
<td>6.0 – 7.0</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>&lt;50 ppm</td>
</tr>
<tr>
<td>Suspended solids</td>
<td>Nil</td>
</tr>
<tr>
<td>Turbidity</td>
<td>Nil</td>
</tr>
<tr>
<td>Iron as Fe</td>
<td>Nil</td>
</tr>
<tr>
<td>Total Hardness</td>
<td>Less than 5 ppm</td>
</tr>
</tbody>
</table>

The Output of RO Water should comply with the BIS 10500 for Drinking Water.

The RO membranes are embedded within the pressure vessel. One side of the membrane is enclosed within the brine seal to avoid the mixing of filtered water and inlet water. Each membrane is connected to the other by means of interconnect or, and has a common permeate end. The filtered water is
collected from the permeate end is sent to drinking and cafeteria usage.

3. Components & specification of Centralized RO Plant are mentioned hereunder:-

3.1. **RO High Pressure Feed Pumps (HPP)** of Vertical multistage centrifugal type and suitable head to generate permeate flow. The pump casing construction shall be of SS-316 & impeller shall be also SS 316. The motor shall be TEFC with IE-3 efficiency suitable for a supply of 415V / 3 Phase at 50 Hz. Supply. The pump shall be supplied complete with base channel, coupling foundation bolts, pressure gauge, valves at inlet and outlet of each pump. (1 working + 1 Standby). RO high pressure pump is water feeding from treated water tank to RO module at high pressure flow.

3.2. **RO Raw Water Pumps (RWP)** of Vertical multistage centrifugal type and suitable head to generate permeate flow as Required. The pump casing construction shall be of SS-316 & impeller shall be also SS 316. The motor shall be TEFC with IE-3 efficiency suitable for a supply of 415V / 3 Phase / 50 Hz. Supply. The pump shall be supplied complete with base channel, coupling foundation bolts, pressure gauge, valves at inlet and outlet of each pump. (Contractor to confirm duty for suitability). (1 working + 1 Standby).

3.3. **Package type RO module** capable of giving a net treated water output as required. The Reverse osmosis module shall be made out of Sprial Wound Thin Film Composite suitable BSPT/NPT connections shall be used for connecting feed and reject ends. The modules shall be supplied complete with all necessary instrumentation, valves for sampling, drain, reject and permeate.

3.4. **Special Antiscalant dosing system** consisting of one HDPE tank of capacity as Required with a positive displacement diaphragm dosing pump having variable flow rate. The motor shall be suitable for operation at 240 V / single phase / 50 Hz supply. The pump shall be supplied complete with necessary polypropylene piping, valves, strainers and injection fittings.

3.5. **Micron cartridge filter** (shall be made of FDA compliant high quality poly propylene material) suitable for a flow rate as Required to achieve particle filtration of less than 5 microns. The unit shall be supplied complete with inlet and outlet branches, removal caps for replacement of elements, inlet and outlet pressure indicator, valves etc. complete in all respect.

3.6. **CIP system (Cleaning in Place)** consisting of HDPE tank with agitator complete with inlet/outlet, drain overflow etc. along with SS pump of capacity as required and cartridge filter of 10 micron. The cartridge filter shall be made of FDA compliant high quality poly propylene material to achieve particle filtration of less than 10 microns.

3.7. **PH correction dosing system** consisting of one HDPE tank with a positive displacement diaphragm dosing pump having variable flow rate as required. The motor shall be suitable for operation at 240 V / single phase / 50 Hz supply. The pump shall be supplied complete with necessary polypropylene piping, valves, strainers and injection fittings.

3.8. **Centralized control panel** made out of CRCA sheet min. 2mm thick having main contactors for all pumps (listed above) including SPP, 3 phase thermal overload relay. The control panel for monitoring and control of RO system shall include all required signal lamps, HRC fuses, and Annunciation box with hooter. All control and power cabling along with double earthing between the panel shall be included in the scope of the contractor. An emergency stop push button shall be provided in the panel.

3.9. **High pressure side piping** from the RO high pressure pumps to the rejects stream control valves shall be of SS 316 using all SS fittings ball valves of suitable pressure rating shall be used till 50 MM size, above 50 MM, flanged globe / water butterfly valves in SS construction shall be used. Rejects pressure control valves shall be globe valve and feed flow control valve shall be of SS 316.

3.10. **SS 316 RO Water storage tank** (Capacity as Required) of minimum 3mm thickness. Tank
shall be provided with water flow meter at inlet & outlet, inlet / outlet valves, overflow / drain connection with MH cover (550 mm I.D.) Tank shall be mounted on 450 mm high steel structural supports with access ladder painted with 2 coats of red oxide paint.

3.11. ELECTRICAL AND INSTRUMENTATIONS

Control Panel : Fixed cubical type with weather proof DOL/Star Delta Starters (as per requirements) consisting of incoming feeder with outgoing feeder feeders, Voltmeters, Ammeter, push button with indicator lamp, overload relays, Contactors, Bus bar of required size, control cabling etc.

Type of panel:

Compartment for individual feeder

MOC:

MS (1.6mm thick sheet) fabricated with powder coating.

Earthing Consist of Copper flats/copper wire of required size for earthing motors, MCC etc. Required compression glands, ferrules, ties, aluminum etc.

Instrumentation

Like level controllers, pressure switches, pressure gauges as required.

3.12 Instruments List including but not limited to (Provision to be considered in the Centralized R.O Plant)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>INSTRUMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Flow Indicator</td>
</tr>
<tr>
<td>2</td>
<td>Pressure Gauge</td>
</tr>
<tr>
<td>3</td>
<td>Pressure Switch (Low &amp; High)</td>
</tr>
<tr>
<td>4</td>
<td>Conductivity Indicator</td>
</tr>
<tr>
<td>5</td>
<td>PH Meter etc.</td>
</tr>
</tbody>
</table>

4. PORTABLE RO WITH SS BODY WATER COOLER

Design, Supply, installation, testing & commissioning of Portable RO with water cooler of 80 LIT (approx.) 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, in situ power saving PUF insulation, no. of faucets (min. 2), 7 stages of filtration (approx.) with speedy drainage facility. The refrigerant shall be eco-friendly & 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.

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 75% in TDS & Hardness parameters. 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.

**Testing, Commissioning & Operation:** After satisfactory installation of the centralized R.O system, entire system shall be tested, commissioned & operated for continuous 15 days as directed by E-I-C.
CHAPTER- Q

TECHNICAL SPECIFICATIONS - BIO MEDICAL WASTE MANAGEMENT SYSTEM

Integrated Sterilizer & Shredder (ISS):

1. Source of the Autoclave:

The system shall use Non-burn Technology. It shall adopt steam sterilization method integrated with a shredder. Process should be in one continuous automated cycle with no use of conveyor belts for transporting waste to a separate shredder. The unit shall not use any chemicals.

2. Capacity:

Chamber Volume shall be 140 to 200 Litres minimum and shall have a capacity to treat minimum 40 kg/hr.

3. Power: 3- phase, 400 V - 440 V, 50 Hz.

4. Loading: Loading shall be from the top. The waste should be able to be loaded in the chamber by a single person without help. The level of loading the waste should not be more than 5 feet from ground level. No stairs or lift should be used for using the machine at any time. It should have a mechanism where the chamber shifts from stationary in any direction for ease of loading and unloading.

5. Unloading:

Waste shall be removed from the vessel automatically. There shall be auto switch off for protection. There shall be a safety system, which should prevent the cycle to start if the door of the machine is open.

6. Chamber:

The treatment vessel shall be vertical (to optimize space occupied) and built of sturdy material like SS 316L or better. There should only be one opening in the chamber.

7. Installation:

Installation area should be less than 160 sq ft.

8. Shredder: Shredder blades shall be of SS/carbon steel material. Shredder mechanism shall be at the bottom of the vessel to optimize full chamber volume.

9. Cycle Duration:

Cycle time should be less than 35 minutes. After treatment, the system should ensure substantial volume reduction in the range of 70 – 90%. Shredding time should be for minimum 7 minutes for better efficiency. It should be able to shred & sterilize waste simultaneously. It should have separate cycle with no shredding option so the machine can also be used as only an autoclave for heavy metals.

10. Temperature range required:

Temperature range shall be minimum 136 degree Celsius and pressure range shall be 2.4 – 5.0 bar with provision for vacuum to ensure proper sterilization. The system should be able to separate liquid and the solid in the chamber itself before unloading the treated waste. A system with an option to cool down the treated material below 60 Celsius degree in less than 3 mins shall be
provided. A system shall be able to take out the air (in order to have proper and efficient sterilization) before sterilization starts through a bio filter in order to avoid any hazardous air exhaust. The final treated waste should be non-reusable. There shall be audio alarm system for printing, door unlock, temperature error, pressure error etc.

11. **PROCESS:**

The system shall be able to treat a mixture and treat different types of waste in one cycle. The system shall be able to treat glass, Scalpels, Blades and Needles. There shall be an automatic washing cycle system. The system shall have one test cycle to detect leakages under pressure.

12. **OPERATION AND CONTROL:**

Cycle should be fully automated and controlled by a microprocessor. Automatic computerized reports of essential sterilizing parameters (selected cycle, start time, cycle stages, temperature/pressure, end time, cycle status i.e. pass/fail) should be possible. Operator LCD Touch Screen should be present with all indicators (selected cycle, start time, cycle stages in graphs as well, temperature/pressure, end time, cycle status i.e. pass/fail). A system should be able to collect the cycle data on a memory chip/card through an integrated slot. For optimal accuracy of sterilization parameters, the system should be equipped with at least 2 temperature sensors and two pressure transducers. There shall be a protective housing with a safety door with a safety switch.

13. **ACCESSORIES REQUIRED:**

There shall be an In-built steam generator. Steam generator shall be automatically controlled by electronic system. It shall have its own R.O. system for water treatment. The system should have a cart or equivalent to collect treated waste. The OEM should provide the same. An integrated printer for data collection and printing shall be provided. An air compressor which has metal sound proof system shall be provided.

14. **CERTIFICATION AND STANDARD:**

- Central / State Pollution Control Board guidelines, latest as amended.

All test certificates as applicable shall be submitted by the EPC Contractor to Engineer-In-Charge.

15. **Other Conditions:**

Any accessories, if required for successful installation, testing & commissioning of the system shall be provided without extra cost.

16. **Testing, Commissioning & Operation:** After satisfactory installation of the system, entire system shall be tested, commissioned & operated for continuous 15 days as directed by E-I-C.
CHAPTER- R

Technical Specifications - Organic Waste Converter

All the Equipment comprising of Composting machine, double curing system & shredder shall be designed to operate 10-12 hrs a day. Accordingly suitable capacity & no. of OWC shall be provided to process approx. 5000 kg biodegradable waste generate per day.

I. Composting Machine
   - Capacity : As Per requirement
   - Power Connection : As Per requirement
   - Brim Capacity : As Per requirement
   - Waste Batch size : As Per requirement
   - Batch Duration : As Per requirement
   - MOC : All contact parts of SS-304.
   - Trolley MoC : MS Powder Coated / S.S 304

II. Double Curing System
   - HDPE crates of adequate size, laminated with aerating net.
   - Four shelf folding storage rack of adequate size.
   - Collection tray of G.I. of adequate size.
   - Double Fogger, Disc Filter, Ball Valve, Pump, Time Control unit for spray and frequency control, pressure gauge, and other accessories like piping, valves etc.

III. Portable Shredder
   - Capacity : As Per requirement
   - Motor : As Per requirement
   - Phase : Single Phase.
   - Weight : As Per requirement
   - Dimension : As Per requirement

Other requirements:
   - Space requirement: It should include segregation, Treatment & storage area.
   - 3 Phase Power supply with suitable electrical panel
   - 4 Pole MCB – No. as required.
   - Single Phase – 5 Amp –3 Pin Switch Socket - No. as required.
   - Single Phase connection – No. as required.
   - 1/2" Dia. Tap for water connection.

Testing, Commissioning & Operation: After satisfactory installation of Organic Waste Converter, entire system shall be tested, commissioned & operated for continuous 15 days as directed by E-I-C.
## CHAPTER- 5

### 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>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 / Salmon / Nocchi / Kirloskar / DP Holland / Wilo</td>
</tr>
<tr>
<td>22.</td>
<td>Level Controller &amp; Indicator (Water)</td>
<td>Auto Pump/Cirrus Engineering/Technika Techtrtl</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>S.No.</td>
<td>Details of equipment/ material</td>
<td>Make/Manufacturer</td>
</tr>
<tr>
<td>-------</td>
<td>------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------</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 / Zoito</td>
</tr>
<tr>
<td>37.</td>
<td>Sodium Hypochlorite Dosing System</td>
<td>Asia LMI/ Grundfos/ Seika / 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/ Viego/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/ Zoito /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>
<tr>
<td>46.</td>
<td>Y Strainer</td>
<td>Emerald/Zoloto /Sant</td>
</tr>
</tbody>
</table>

**HOT WATER GENERATOR SYSTEM**

1. Air release valve/ Insulation/ Thermometer/ Pressure Gauge  
   As per Approved makes for HVAC Works.

2. Ball valve /Check valve/“Y” – strainer/ GI/MS pipes  
   As per Approved makes for Fire Fighting Works.

3. Hot Water Generators  
   Enmax/ Sunmax/ Goodsun / TATA Power Solar / Thermax/ Rapid Control

4. Recirculating pumps  
   Grundfos/ DP /Mather Platt – Wilo/KSB

**SOLAR PV/ HOT WATER SYSTEM**

1. Solar PV System  
   TATA Power Solar / Havells Solar Edge/ Mosaer Baer/ Jackson Solar

2. Solar Hot Water System  
   HoneyWell / Solahart / Sol. Power/ TATA Power Solar/Bosch/Solimpeks

3. Butterfly Valve  
   Audco/Danfoss/Honeywell/Zoloto

4. Check Valve – Dual Plate  
   Advance/Honeywell/Audco/Zoloto

5. Check Valve – Wafer Type  
   Advance/Danfoss/Zoloto/Honeywell

6. CPVC pipes  
   Supreme/Ashirwad/Astral

7. GI Pipes  
   Tata Steel/Jindal (Hissar)/ SAIL

8. GM / Forged Brass Ball Valves  
   Danfoss/Honeywell/Zoloto

9. Heat Exchanger  
   GEA Eco flex/Alfa Level or equivalent

10. Hot Water Recirculation OR other Pumps  
    DP – Holland/Grundfos /Xylem -ITT/ Wilo – Mather Platt
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Details of equipment/material</th>
<th>Make/Manufacturer</th>
</tr>
</thead>
<tbody>
<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 / Techtril</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>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, Climavenetra/Certkin</td>
</tr>
</tbody>
</table>

**ELECTRICAL WORKS**

<p>| 1.     | 11 KV HT Panel with 11kV Vacuum Circuit Breaker (VCB) | L&amp;T/ ABB / Schneider/ Siemens or their authorized Channel Partner |
| 2.     | 33/66 kV HT Panel with 33/66 kV SF6 Breaker | L&amp;T/ ABB / Schneider/ Siemens or their authorized Channel Partner |
| 3.     | 33/66 kV HT Panel with 33/66 kV Vacuum Circuit Breaker (VCB) | L&amp;T/ ABB / Schneider/ Siemens or their authorized Channel Partner |
| 4.     | ACB (TP,4P) with variable microprocessor | L&amp;T (U-Power Omega)/ Siemens (3 WL)/ Schneider (Nw Masterpact)/ ABB (Emax) |
| 5.     | Automatic Transfer Switch (ATS) | L&amp;T/ ABB/ Siemens/ Schneider / Socomec |
| 6.     | Auxiliary relays compatible with PLC etc. | Siemens/ L&amp;T/ ABB/ Areva/ Schnieder |
| 7.     | Batteries | Hitachi/Panasonic/ Yuasa/ SF/ Exide/ Amco/ Amraja |
| 8.     | Battery Charger | Amaraja/ Sabnife/ Statcon/ Voltstat/ HBL |
| 10.    | Boom Barrier | FAAC/ Godrej Vigiguard/ Somfy/Gunnebo |
| 11.    | Brass compression Gland (Heavy duty) | Comex/ Gripwell/ Dowell |
| 12.    | Bus bar | Jindal/ Hindalco/ Indal |
| 13.    | Bus Duct - Sandwich | L&amp;T/ Schneider/ C&amp;S/ Godrej/ Legrand/ EAE |
| 14.    | Bus trunking , rising mains, end feed unit, top-off box (plug-in type) | L&amp;T/ Schneider/ C&amp;S/ Godrej /Legrand/ EAE |
| 15.    | Cable Jointing Kit / HT termination Kit | Reychem/ Xicon/ 3M |
| 16.    | Cable Lugs &amp; Glands | Dowel/ Johnson/ Gripwell/ Comex/ Hex/ Comet |
| 17.    | Cable Tray/ Race ways / Floor trunking / wall channels | MEM/ BEC/ MK/ OBO Bettermann/ Indiana/ Legrand/Sai Metal Craft |
| 18.    | Capacitors with harmonic filters | L&amp;T/ Siemens / Schneider/ ABB/ Ducati |
| 19.    | Ceiling /Exhaust/Wall fans | Crompton/ Usha/ Orient/ Bajaj/ Havells |
| 20.    | Chemical Earthing | JMV LPS Ltd./ Pragati Electrocom |</p>
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Details of equipment/ material</th>
<th>Make/Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.</td>
<td>Coaxial Wires</td>
<td>Finolex/ Delton/ Skytone/ L&amp;T/ KEI/ Finolex/ Gloster</td>
</tr>
<tr>
<td>22.</td>
<td>Colour Monitor</td>
<td>Samsung/ LG/ Sony/ Philips</td>
</tr>
<tr>
<td>23.</td>
<td>Compression Gland and Lugs / thimbles</td>
<td>Dowel/ Comet/ Gripwell</td>
</tr>
<tr>
<td>24.</td>
<td>Contactors</td>
<td>ABB/ L&amp;T/ Schneider/ Siemens</td>
</tr>
<tr>
<td>25.</td>
<td>Control fuse base with HRC fuse / HRC Fuse</td>
<td>L&amp;T/ Siemens/ ABB/ Alstom/ Schnieder</td>
</tr>
<tr>
<td>26.</td>
<td>Crimping Lugs/ Thimbles</td>
<td>Dowells/ Hex/ Commet</td>
</tr>
<tr>
<td>27.</td>
<td>CT/ PT's</td>
<td>L&amp;T/ Kappa/ C&amp;S/ CGL/ AE / Meco</td>
</tr>
<tr>
<td>28.</td>
<td>Cubicle Type Fuse Unit/ RMU</td>
<td>Siemens/ L&amp;T/ ABB/ Schneider</td>
</tr>
<tr>
<td>29.</td>
<td>Data/Telephone/TV Outlets</td>
<td>Systemax/ Belden/ Simone/ MK/ Legrand/ Havells/ Anchor</td>
</tr>
<tr>
<td>30.</td>
<td>DB's / Pre-wired DB's</td>
<td>Hager/ Havells/ Legrand/ L&amp;T/ Schneider/ ABB/ Siemens</td>
</tr>
<tr>
<td>32.</td>
<td>DG Set - Alternator</td>
<td>Stamford/ Leroy Somer/ Toyo Denki/ AVK-SEG/ Kirloskar (KOEL Green)</td>
</tr>
<tr>
<td>33.</td>
<td>DG Set - Engine</td>
<td>Cummins/ Mitsubishi/ Perkins/ Volvo/ Caterpillar/ Kirloskar (KOEL Green)</td>
</tr>
<tr>
<td>34.</td>
<td>DG Synchronizing Controller</td>
<td>Woodward/ Dief/ Deep sea</td>
</tr>
<tr>
<td>35.</td>
<td>Digital Lighting Control System</td>
<td>Wipro/ Siemens/ Philips/ Schneider/ ABB/ L&amp;T</td>
</tr>
<tr>
<td>36.</td>
<td>Digital Numerical Relays</td>
<td>L&amp;T/ ABB / Siemens/ Schneider/ Areva</td>
</tr>
<tr>
<td>37.</td>
<td>DWC HDPE Pipe</td>
<td>DURA-LINE / REX / CARLON/ EMTELLE</td>
</tr>
<tr>
<td>38.</td>
<td>Digital Energy Meters including Dual Source Energy Meters</td>
<td>L&amp;T/ Rishabh/ Schneider/ HPL/ Siemens/ ABB/ Socomec/ Neptune</td>
</tr>
<tr>
<td>39.</td>
<td>Electrical Motors</td>
<td>L&amp;T/ ABB/ Siemens/ Kirloskar</td>
</tr>
<tr>
<td>40.</td>
<td>Optical Fiber Cable</td>
<td>Sterlite Technologies/ Finolex/ Belden/ Delton/ Skytone</td>
</tr>
<tr>
<td>41.</td>
<td>Fire Extinguisher</td>
<td>Ceasefire/ Exflame/ Minimax/ Life Guard/ Safex</td>
</tr>
<tr>
<td>42.</td>
<td>Fire Survival Cables</td>
<td>KEI/ Polycab/ Havells/ Fusion Polymers</td>
</tr>
<tr>
<td>43.</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/ Batra henlay</td>
</tr>
<tr>
<td>44.</td>
<td>G.l./Cu. Strip &amp; earthing material</td>
<td>Bharati/ Indiana/ Slotco</td>
</tr>
<tr>
<td>45.</td>
<td>Hand Gloves &amp; Rubber Mat</td>
<td>Premier Polyfilm Ltd/ Polyelectrosafe/ Challenger/ Electromat/ Safe Hold</td>
</tr>
<tr>
<td>46.</td>
<td>HRC Fuse</td>
<td>Siemens/ L&amp;T/ ABB/ Schneider</td>
</tr>
<tr>
<td>47.</td>
<td>HT &amp; LT Cables (Power &amp; Control Cables, Solar Cables)</td>
<td>Gloster/ Havells/ Nicco/ Finolex/ KEI/Polycab</td>
</tr>
<tr>
<td>48.</td>
<td>Indicating Lamps</td>
<td>AE/ Kaycee/ Vaishnav/ L&amp;T/ Siemens/</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>49.</td>
<td>Industrial Socket Outlets</td>
<td>ABB/ L&amp;T/ Legrand/ Siemens/ Hager</td>
</tr>
<tr>
<td>50.</td>
<td>Insulated Rubber Mat</td>
<td>Premier Polyfilm Ltd/ Polyelectrosafe/ Challenger/ Electro Mat/ Safe Hold</td>
</tr>
<tr>
<td>51.</td>
<td>Insulators</td>
<td>Jaya Shree/ Modern/ IEC/ WSI</td>
</tr>
<tr>
<td>52.</td>
<td>Intelligent Detectors/ Hooters &amp; accessories</td>
<td>Notifier-Honeywell/ Schneider/ Edwards/ Siemens/ L&amp;T</td>
</tr>
<tr>
<td>53.</td>
<td>Intelligent Fire Alarm Panel</td>
<td>Notifier/ Honeywell/ Schneider/ Edwards/ Siemens/ L&amp;T</td>
</tr>
<tr>
<td>54.</td>
<td>Inverter</td>
<td>Microtek / Luminous / Su-Kam/ Eaton</td>
</tr>
<tr>
<td>55.</td>
<td>Isolators</td>
<td>Siemens/ L&amp;T/ ABB/ Socomec/ Schnieder</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/ Havells</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 Arrestors</td>
<td>L&amp;P ELECTRO/ LPI/ Indelec</td>
</tr>
<tr>
<td>60.</td>
<td>LT Panels / Synchronizing Panels/ Capacitor Panels</td>
<td>L&amp;T/ ABB / Schneider/ Siemens or their authorized Channel Partner</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</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)/ Siemens(3 VL)/ ABB (T max)/ Schneider (NSX)</td>
</tr>
<tr>
<td>63.</td>
<td>Measuring Instruments (Analog Meter)</td>
<td>L&amp;T/ AE/ MECO/ Rishabh/ Schnieder</td>
</tr>
<tr>
<td>64.</td>
<td>Measuring Instruments (Digital Type)/ MFM/KWH meter</td>
<td>L&amp;T/ Ducati/ Conzerv/ Secure/ Siemens/ Schnieder/ ABB</td>
</tr>
<tr>
<td>65.</td>
<td>Modular Switches/ Socket outlets and wiring accessories with moulded cover plate</td>
<td>MK (wraparound plus) / Siemens (Delta)/ Legrand (mylinc)/ L&amp;T (Entice)/ Havells (Crab tree-Athena)/ Anchor (Roma)/ Schneider (Opale)/ Wipro (North-West)</td>
</tr>
<tr>
<td>66.</td>
<td>MPCB</td>
<td>L&amp;T/ Siemens/ ABB/ Schnieder</td>
</tr>
<tr>
<td>67.</td>
<td>MS Conduit</td>
<td>BEC/ AKG/ Steel Kraft</td>
</tr>
<tr>
<td>68.</td>
<td>MS Conduit accessories</td>
<td>BEC/ AKG/ Steel Kraft</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/L&amp;T/ Siemens</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/ Schnieder/ C&amp;S</td>
</tr>
<tr>
<td>74.</td>
<td>Panel Accessories</td>
<td>L&amp;T/ Teknic/ Rishabh/ Siemens/ Schnieder</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/ Schnieder</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>77.</td>
<td>Protective relays (Microprocessor based compatible with PC &amp; PLC)</td>
<td>Siemens/ L&amp;T/ ABB/ Areva/ Schnieder</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</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/ Schnieder/ ABB</td>
</tr>
<tr>
<td>82.</td>
<td>Street Light Poles &amp; Light Fixtures – Solar &amp; Conventional</td>
<td>Philips/ Wipro/ Havells/ Bajaj/ Keselac Schreder</td>
</tr>
<tr>
<td>83.</td>
<td>Surge Diverter</td>
<td>Tercel/ ABB/ Siemens/ Emerson/ Hager/ Phoenix/ Legrand</td>
</tr>
<tr>
<td>84.</td>
<td>SCADA &amp; BMS System</td>
<td>Schneider/ L&amp;T/ Honeywell / Siemens/ABB</td>
</tr>
<tr>
<td>85.</td>
<td>Tap-off/ Splitter box</td>
<td>Zinwell/ Novatron/ Catvision</td>
</tr>
<tr>
<td>86.</td>
<td>Telephone Tag Block/Jack Panel/ Face Plate</td>
<td>Krone/ Phoenix/ Wago/ Beldon/ Panduit/ Huawei</td>
</tr>
<tr>
<td>87.</td>
<td>Terminal Strip</td>
<td>Connect well/ Phoenix/ WAGO</td>
</tr>
<tr>
<td>88.</td>
<td>Termination Kits</td>
<td>Raychem/ Birla/ 3M</td>
</tr>
<tr>
<td>89.</td>
<td>Transformer (Oil Type / Dry Type)</td>
<td>ABB/ Siemens/ Kirloskar/ Voltamp/ Areva/ Schneider</td>
</tr>
<tr>
<td>90.</td>
<td>Trivector - Meter (Digital type) only for SEB supply</td>
<td>L&amp;T/ Secure meter / Enercon/ Siemens/ Socomec/ Schnieder</td>
</tr>
<tr>
<td>91.</td>
<td>UPS</td>
<td>Emerson (Vertiv)/ Schnieder (APC)/ Eaton/ Socomec</td>
</tr>
<tr>
<td>92.</td>
<td>Variable Frequency Drive</td>
<td>L&amp;T/ Siemens/Danfoss/ABB/ Schneider</td>
</tr>
</tbody>
</table>

**FIRE FIGHTING WORKS**

<p>| 1.    | Air Release Valve/Air Cushion Tank | Zoloto/Advance/Leader/Audco/Castle |
| 2.    | Alarm valve &amp; Hydraulic (Alarm motor with coupling) | HD fire protect/TYCO/VIKING/Newage |
| 3.    | Alternator                        | Stamford/ Lorey Somer/ Kirloskar/ Toyo Denki/ AVK |
| 4.    | Ammeter/ Voltmeter/ PF/ kW/ Hz/ meter /Energy Meter/ Multimeter | As per respective electrical make list |
| 5.    | Anchor Fastener                   | Fischer / Hilti or equivalent |
| 6.    | Ball Valves                       | L&amp;T/ Audco /Zoloto/ Advance/Emerald/ KSB |
| 7.    | Battery                           | Exide/ AMCO /Amararaja/ Panasonic |
| 8.    | Butt welded fitting (UL Listed) &amp; accessories | V.S. Forge/True Forge / DRP-M |
| 9.    | Butterfly valves                  | L&amp;T/ Audco/ Zoloto / Advance/ KSB     |
| 10.   | Cable lugs and glands             | As per electrical make list          |
| 11.   | Cables                            | As per electrical make list          |
| 12.   | Check Valve/ Foot Valve/ Sluice Valve/ | L&amp;T/Audco / Zoloto Advance/KSB     |</p>
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Details of equipment/ material</th>
<th>Make/Manufacturer</th>
</tr>
</thead>
<tbody>
<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>34.</td>
<td>Pressure Gauge</td>
<td>Fiebig / H.GURU / HD / BRC</td>
</tr>
<tr>
<td>35.</td>
<td>Pressure Switch</td>
<td>Indfoss / Switzer / Danfoss / Honeywell</td>
</tr>
<tr>
<td>36.</td>
<td>Push Buttons/ Indicating lamps LED</td>
<td>As per respective electrical 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>S.No.</td>
<td>Details of equipment/ material</td>
<td>Make/Manufacturer</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------------------------------------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>42.</td>
<td>Weld Electrodes</td>
<td>Advani/ ESAB/ L&amp;T/Victor</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>Clean Agent Fire Extinguisher</td>
<td>Kanex/Tyco/Newage/SVS Buildwell/Minimax/Lifeguard/</td>
</tr>
</tbody>
</table>

**FIRE ALARM SYSTEM**

Note: All fire alarm components/ Panels shall be UL listed & confirm to NFPA standards.

1. Control Cable       RR Cable/ Bonton/ Havells/ Polycab/ Finolex
2. Intelligent Addressable Fire Alarm Panel/Detectors/ Hooters/ Manual Call Point UL Listed/ Talkback/ Control Module/ Monitor Module/ Control relay Module/ Short Ckt. Isolator/ Honeywell-Notifier/ Siemens/ Schneider/ Bosch/ GE Edwards/Tyco
3. Intelligent Addressable Fire Alarm System Honeywell-Notifier/ Siemens/ Schneider/ Bosch/ GE Edwards/Tyco
4. Response Indicator Morlay/Seimens Finder/ GE Edwards/ Honeywell-Notifier
5. Fire Survival Cable Bonton/ Skytone/ Fusion Polymers/KEI
6. Fire Annunciation Panel Minilec/ Honeywell-Notifier/ Siemens/ Tyco - Simplex
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 Lifts Pvt. Ltd.

**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/ GE/Bosch/HID/ Lenel
2. E Magnetic lock Cisa/Faraday/Trimec
3. Amplifier Bosch/ Honeywell/Bose
4. CAT 6A Wire/Accessories -Jack panel / Face Plate Huwavei/ Belden / Panduit/ Commscope/ Simone/Legrand
5. CCTV Camera/ NVR/ Central Monitoring Software / Other Items Honeywell / Pelco /Cisco / Bosch/ GE/ Axis/ Sony
6. CD Player Bosch/ Honeywell/Bose
7. Door Interlocking System NRH/Eltech/Avon or equivalent
8. PA Speaker, Voice controller, paging Bosch/ Honeywell/Bose
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Details of equipment/ material</th>
<th>Make/Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.</td>
<td>RG 6,RG 11/Wire/Coaxial Cables</td>
<td>Belden/ Skytone/ Bonton/ Finolex</td>
</tr>
<tr>
<td>10.</td>
<td>Speaker Wire</td>
<td>Bonton/Delton/Polycab</td>
</tr>
<tr>
<td>11.</td>
<td>Data Storage device</td>
<td>Quantum/ HP/ DELL/ IBM</td>
</tr>
<tr>
<td></td>
<td><strong>HVAC SYSTEM</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>2-Way Pressure Independent Balancing &amp; Control Valve</td>
<td>Siemens/ Danfoss/Oventrop /Belimo</td>
</tr>
<tr>
<td>2.</td>
<td>Adhesives for Insulation</td>
<td>Pidilite/Superlon / Armacell</td>
</tr>
<tr>
<td>3.</td>
<td>Adjustable Frequency Drive/ Automatic AFD Bypass/ Pump Controller/ Differential Pressure Sensor/ Transmitter</td>
<td>Xylem-ITT/Grundfos/Armstrong or as per OEMs</td>
</tr>
<tr>
<td>4.</td>
<td>Air cooled package units</td>
<td>Voltas/ Bluestar/HITACHI or equivalent</td>
</tr>
<tr>
<td>5.</td>
<td>Air &amp; Dirt Separator/Dirt Separator</td>
<td>Spirotech/ Calefi/ Optivent /Spirotherm/Flamo/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 washer</td>
<td>Zeco/ Waves/ Edgetech/ VTS/Humidin</td>
</tr>
<tr>
<td>9.</td>
<td>Aluminium Sheet for Ducts</td>
<td>Jindal/ Hindalco/ Indal</td>
</tr>
<tr>
<td>10.</td>
<td>Automatic Air Vent</td>
<td>Anergy / Rapid Cool/Emerald/CIM</td>
</tr>
<tr>
<td>12.</td>
<td>Balancing Valves (Water Duty)</td>
<td>As per Approved Makes of Electrical Works</td>
</tr>
<tr>
<td>13.</td>
<td>Ball valves (With &amp; W/O Strainers)</td>
<td>Audco /KSB/Advance/ L&amp;T /Zoloto</td>
</tr>
<tr>
<td>14.</td>
<td>Butterfly Valves (Water Duty)</td>
<td>Advance / Audco/ L&amp;T/Zoloto/KSB</td>
</tr>
<tr>
<td>15.</td>
<td>Cable Lugs/Thimbles/Glands</td>
<td>As per Approved Makes of Electrical Works</td>
</tr>
<tr>
<td>16.</td>
<td>Cable Tray</td>
<td>As per Approved Makes of Electrical Works</td>
</tr>
<tr>
<td>17.</td>
<td>CAV Box/VAV Box</td>
<td>Trox/ System Air / Ruskin Titus /Honeywell/Johnson’s Control/Belimo</td>
</tr>
<tr>
<td>18.</td>
<td>Centrifugal Fans/Fan section/Plug Fans</td>
<td>Kruger / Greenheck /Comefri/ Wolter/ Nicotra/Systemair</td>
</tr>
<tr>
<td>19.</td>
<td>Check Valve/ Foot Valve/Sluice Valve/NRV</td>
<td>Advance / Audco/ L&amp;T/Zoloto/KSB</td>
</tr>
<tr>
<td>20.</td>
<td>Chilled Water Pump (Primary/Secondary)/ Condenser/Hot Water Pumps etc.</td>
<td>Armstrong /Grundfoss/Xylem -ITT</td>
</tr>
<tr>
<td>21.</td>
<td>Control Cables</td>
<td>As per Electrical Makes</td>
</tr>
<tr>
<td>22.</td>
<td>Cooling Tower</td>
<td>Bell / Paharpur/Flowtech/Nihon Spindle</td>
</tr>
<tr>
<td>23.</td>
<td>CPRX Compound/Tar felt</td>
<td>Shalimar tar product / Asian / Pidilite</td>
</tr>
<tr>
<td>24.</td>
<td>DRY Scrubber</td>
<td>Rydair/ Trion/ Honeywell</td>
</tr>
<tr>
<td>25.</td>
<td>Duct Dampers/ Grills/ Diffuser/ VCD/ Collar Damper etc.</td>
<td>Caryaire / Systemair/ Conaire/ Dynacraft /Airflow (Mapro)</td>
</tr>
<tr>
<td>26.</td>
<td>Electric Motor</td>
<td>ABB/ Siemens/ Crompton Greaves / BALDOR</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>27.</td>
<td>Electric motor (Fire Rated)</td>
<td>Marathon/ Havells-Lafert/ Baldor/ ROTOMOTIVE</td>
</tr>
<tr>
<td>28.</td>
<td>Expansion Tank</td>
<td>Xylem-ITT/ Armstrong/ Grundfos /Flamco</td>
</tr>
<tr>
<td>30.</td>
<td>Fan Coil Units with Fans</td>
<td>VTS/Flaktwood/Daikin/Carrier/Johnson Control</td>
</tr>
<tr>
<td>31.</td>
<td>Fasteners-Dash</td>
<td>HILTI / Fischer / Cannon / Wurth</td>
</tr>
<tr>
<td>32.</td>
<td>FCU Copper Connection Set/ FCU Link</td>
<td>ATS/ Oventrop/ CSI</td>
</tr>
<tr>
<td>33.</td>
<td>Filters -Pre/ Fine/ Hepa &amp; BIBO</td>
<td>Thermadyne / Spectrum / Camfil/ American Air Filter</td>
</tr>
<tr>
<td>34.</td>
<td>Fire Damper Actuator</td>
<td>Belimo/Siemens/Danfoss/Honeywell</td>
</tr>
<tr>
<td>35.</td>
<td>Fire Dampers / Smoke Dampers</td>
<td>Trox/ Greenheck/Ruskin Titus/Systemair</td>
</tr>
<tr>
<td>36.</td>
<td>Flexible Duct Connection</td>
<td>Airflow/Pyroguard / Rolastar / UP Twiga</td>
</tr>
<tr>
<td>37.</td>
<td>Flexible Pipe Connection</td>
<td>Resistoflex/ Easyflex/ Diamond/ Dunlop</td>
</tr>
<tr>
<td>38.</td>
<td>FRP lining for condenser piping</td>
<td>Owen-corning/UP Twiga/Binani</td>
</tr>
<tr>
<td>39.</td>
<td>GI/ MS Piping (chilled/condenser/drain/hot)</td>
<td>Jindal-Hissar/TATA/SAIL</td>
</tr>
<tr>
<td>40.</td>
<td>Globe/Gate Valve</td>
<td>Audco / Advance / Danfoss/L&amp;T/KSB/Zoloto</td>
</tr>
<tr>
<td>41.</td>
<td>Heat Recovery Exchanger/ Ventilator/ Wheel</td>
<td>Ostberg/DRI / Flaktwoods/ Heatex/ BryAir</td>
</tr>
<tr>
<td>42.</td>
<td>Hot Water Generators</td>
<td>KEPL / Rapid cool/ Emerald/Enmax</td>
</tr>
<tr>
<td>43.</td>
<td>Humidifier</td>
<td>KEPL / Rapid cool/ Emerald /Enmax</td>
</tr>
<tr>
<td>44.</td>
<td>Inline Fans</td>
<td>Kruger / Nicotra/ Greenheck/ Ostberg</td>
</tr>
<tr>
<td>45.</td>
<td>Insulation Material</td>
<td></td>
</tr>
<tr>
<td>46.</td>
<td>a) Fiber Glass – Aluminium faced Insulation</td>
<td>UP Twiga / Owens Corning/Kimmco</td>
</tr>
<tr>
<td>47.</td>
<td>b) Polyurethane Foam (PUF) Insulation</td>
<td>Styrene Packaging &amp; Insulations/Lloyd Insulations/Supreme</td>
</tr>
<tr>
<td>48.</td>
<td>c) Nitrile Rubber /EPDM Insulation with antimicrobial</td>
<td>K-Flex/Superlon/Armacell/Supreme</td>
</tr>
<tr>
<td>49.</td>
<td>d) XLPE Insulation</td>
<td>Supreme/ Vidoflex/ Trocellene</td>
</tr>
<tr>
<td>50.</td>
<td>e) Expanded Polystyrene Insulation</td>
<td>Styrene Packing/Mettur Beardsell/ Toshiba/Trocellin/ Thermobreak</td>
</tr>
<tr>
<td>51.</td>
<td>Laminar Flow HEPA tent</td>
<td>Systemair/TROX/American Air Filter/ Conaire/ Thermadyne/ Airttech</td>
</tr>
<tr>
<td>52.</td>
<td>Magnehelic Gauges</td>
<td>Mitbhraus Instruments/ Dwyer / Omicron</td>
</tr>
<tr>
<td>53.</td>
<td>Paints</td>
<td>As per Civil Works Makes</td>
</tr>
<tr>
<td>54.</td>
<td>Pre insulated Ducts</td>
<td>Pal/Zeco/ ALP/ Kingspan/ Spiro / UP Twiga</td>
</tr>
<tr>
<td>55.</td>
<td>Pipe Supports</td>
<td>EASYFLEX/Resistoflex/Diamond</td>
</tr>
<tr>
<td>56.</td>
<td>Pipe Supports-PUF</td>
<td>Llyod insulation/ Melanpur/ Beardsell</td>
</tr>
<tr>
<td>57.</td>
<td>Power Cables</td>
<td>As per Electrical Makes</td>
</tr>
<tr>
<td>58.</td>
<td>Pressure /Temperature Gauges</td>
<td>H.Guru / Feibig / Warree/H.D/BRC</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>59.</td>
<td>Propeller Fans</td>
<td>Crompton/Khaitan/Alstom/Bajaj/GE</td>
</tr>
<tr>
<td>60.</td>
<td>Thermostat/Humidistat</td>
<td>Honeywell/Johnson/Siemens/Schneider</td>
</tr>
<tr>
<td>61.</td>
<td>Purge Valve/Drain Valve</td>
<td>Audco/Advance/Anergy/Zoloto</td>
</tr>
<tr>
<td>62.</td>
<td>PVC/uPVC pipe</td>
<td>Polypack/Supreme/Astral/Finolex</td>
</tr>
<tr>
<td>63.</td>
<td>Red Oxide/Zinc Chromate Primer</td>
<td>As per Civil Works Makes</td>
</tr>
<tr>
<td>64.</td>
<td>Refrigerant Copper Pipes</td>
<td>MANDEV Tubes/Rajco Metal/Mehta Tubes (Max Flow)/Kwality Tubes (Raj State)</td>
</tr>
<tr>
<td>65.</td>
<td>Room Thermostat</td>
<td>Honeywell/Johnson/Siemens/Schneider</td>
</tr>
<tr>
<td>66.</td>
<td>RP Tissue</td>
<td>UP Twiga/Styrene Packing or equivalent</td>
</tr>
<tr>
<td>67.</td>
<td>Split AC Units/Precision AC</td>
<td>Toshiba/Daikin/Hitachi/Carrier</td>
</tr>
<tr>
<td>68.</td>
<td>Starters/change over switch/push buttons/Indication Lamps/Rotary switches/1-phase preventer/Soft starter/MCB/MCCB/ACB/Contactor etc.</td>
<td>As per respective Electrical Makes</td>
</tr>
<tr>
<td>69.</td>
<td>Strip Heater</td>
<td>Das Pass/Escorts/KEPL or equivalent</td>
</tr>
<tr>
<td>70.</td>
<td>UV &amp; Weather protective Coating</td>
<td>Pidilite/Foster/Amicon</td>
</tr>
<tr>
<td>71.</td>
<td>UVGI System (Ultra Violet Germicidal-Irradiation System)</td>
<td>Ruks/Trimed/Sterile Air</td>
</tr>
<tr>
<td>72.</td>
<td>V Belt</td>
<td>Dunlop/Fenner/Hilton</td>
</tr>
<tr>
<td>73.</td>
<td>Vacuum Degasser</td>
<td>Spirotech/Optivent/Calefi/Comfort/Spirotherm/Flamco</td>
</tr>
<tr>
<td>74.</td>
<td>Variable Frequency Drive</td>
<td>Siemens/Danfoss/ABB/Schneider/L&amp;T</td>
</tr>
<tr>
<td>75.</td>
<td>VRV/VRF Outdoor/Indoor Units/Refnet Joints/Remote Controllers</td>
<td>Mitsubishi Electric/Daikin/Toshiba/Panasonic/Carrier</td>
</tr>
<tr>
<td>76.</td>
<td>Chillers</td>
<td>Daikin-Mcquay/Carrier/Trane/York/Dunham Bush</td>
</tr>
<tr>
<td>77.</td>
<td>Water Flow Switch</td>
<td>Honeywell/Danfoss/Belimo/Emerald/Rapid Cool</td>
</tr>
<tr>
<td>78.</td>
<td>Vibration Isolators</td>
<td>Easyflex/kanwal/ResistoFlex</td>
</tr>
<tr>
<td>79.</td>
<td>Air Ionizers/Air Purification System</td>
<td>Plama Air/Aerisa/Bentaxna/RGF/Aquaair</td>
</tr>
<tr>
<td>80.</td>
<td>Pot Strainer</td>
<td>Emerald/VTM/Rapid Cool</td>
</tr>
<tr>
<td>81.</td>
<td>Y-Strainer</td>
<td>Zoloto/Audco/Emerald/Rapid cool/Advance</td>
</tr>
<tr>
<td>82.</td>
<td>Chilled Water Cassette Unit</td>
<td>Carrier/TRANE/Daikin/Johnson Control</td>
</tr>
<tr>
<td>83.</td>
<td>Motorized Butterfly Valve</td>
<td>Honeywell/Belimo/Danfoss/Siemens</td>
</tr>
</tbody>
</table>

**IBMS SYSTEM**

1. Operator Workstation | Dell/Lenovo/HP/IBM |
2. Printer              | Canon/Xerox/HP/Epson |
3. Network Switch       | Cisco/D-Link/HP/Allied Telesis |
4. Capacitive Touch Panel | Siemens/Honeywell/Schneider/ALC |
5. BMS Software         | Siemens/Schneider/L&T/Honeywell |
6. System Integration Units | Siemens/Schneider/Johnson Controls/Delta |
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Details of equipment/ material</th>
<th>Make/Manufacturer</th>
</tr>
</thead>
<tbody>
<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>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 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**

1. Air Blowers | Beta/ Everest/ Kulkarni / TMVT |
2. Air Diffusion System | Airfin/Usha Ruba/Rehau |
3. Air Vent Valve | Oven trop (Germany) / CIM / Rapid Control |
4. Anti Corrosive Tape for Pipe protection | Pyepcoat / Marphalt / Cotek/STP |
5. Ball Valve | Zoloto/Honeywell/RB |
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Details of equipment/ material</th>
<th>Make/Manufacturer</th>
</tr>
</thead>
<tbody>
<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 / Phydro / 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>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</td>
</tr>
<tr>
<td>41.</td>
<td>Resin</td>
<td>Thermmax / 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>S.No.</td>
<td>Details of equipment/ material</td>
<td>Make/Manufacturer</td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------------</td>
<td>------------------</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></th>
<th>Details of equipment/ material</th>
<th>Make/Manufacturer</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 PHONES/ Handsets/IP phones</td>
<td>BEETEL/ PANASONIC/ SIEMENS/ ALCATEL/CISCO</td>
</tr>
<tr>
<td>3.</td>
<td>IPABX Server and Gateways</td>
<td>ALCATEL/ MATRIX/ AVAYA/ CISCO/ SIEMENS/ NORTEL</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/ Huawei/ Legrand/Amp</td>
</tr>
<tr>
<td>6.</td>
<td>VOICE BOX – RJII</td>
<td>KRONE/ TVS/ FINOLEX</td>
</tr>
</tbody>
</table>

**DATA NETWORKING & WIFI SYSTEM**

<table>
<thead>
<tr>
<th></th>
<th>Details of equipment/ material</th>
<th>Make/Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Active Components – Core and Edge switch</td>
<td>CISCO/ Juniper/HP</td>
</tr>
<tr>
<td>2.</td>
<td>Enclosures – Distribution rack and server rack</td>
<td>APW/ Nettack / Rittal / Legrand/MTS</td>
</tr>
<tr>
<td>3.</td>
<td>Ethernet Switch / Indoor &amp; Outdoor WIFI device/ Transreceivers</td>
<td>CISCO/ JUNIPER/HP</td>
</tr>
<tr>
<td>4.</td>
<td>Routers</td>
<td>ALCATEL/ AVAYA/ CISCO/HP/JUNIPER</td>
</tr>
<tr>
<td>5.</td>
<td>Server</td>
<td>IBM / Dell / HP/ CISCO</td>
</tr>
<tr>
<td>6.</td>
<td>Firewall</td>
<td>CISCO/ Juniper/HP/Fortinet/Palo Alto</td>
</tr>
<tr>
<td>7.</td>
<td>Passive Components – Cat 6/Cat 6A/ Patch panel/ Patch Cord/ Information outlets/ Optical fiber Cable/ Fiber patch cord/ pigtails/ LIU/ Adapters/ Connectors</td>
<td>Amp/Belden/ Simone/Panduit/Le grand/ CISCO</td>
</tr>
</tbody>
</table>

**Audio Visual System & Stage Lighting System for Auditorium & Conference Rooms**

<table>
<thead>
<tr>
<th></th>
<th>Details of equipment/ material</th>
<th>Make/Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>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>2.</td>
<td>DVD cum USB Player</td>
<td>Sony/ Philips/ Samsung/ Bose</td>
</tr>
<tr>
<td>3.</td>
<td>Equipment Rack</td>
<td>Rittal/ Nettack/ Cisco/MTS/APW</td>
</tr>
<tr>
<td>4.</td>
<td>PVC Conduits &amp; Raceways</td>
<td>AKG/BEC/ Hensal/ Clipsal/ Polypack/ Precision</td>
</tr>
</tbody>
</table>
## Details of equipment/ material

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description</th>
<th>Make/Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>LED Dimmable Lights</td>
<td>Philips/ Wipro/ Havells/ Lutron/Trilux</td>
</tr>
<tr>
<td>6.</td>
<td>LED Signage Board</td>
<td>Wipro/ Philips/ Baja/Instapower/Decon</td>
</tr>
<tr>
<td>7.</td>
<td>Video Projector</td>
<td>Christie/ Sony/ Panasonic/Philips</td>
</tr>
<tr>
<td>8.</td>
<td>Projection Screen</td>
<td>Draper/ Da-Lite/ Grandview/ Harkness</td>
</tr>
<tr>
<td>9.</td>
<td>LED Display Monitors</td>
<td>LG/ Sony/ Panasonic/ Philips/Samsung</td>
</tr>
<tr>
<td>10.</td>
<td>Video Conferencing Unit</td>
<td>Sony/ Polycom/ Palco/ Cisco</td>
</tr>
<tr>
<td>11.</td>
<td>HD PTZ Camera, Joystick</td>
<td>Sony/ Panasonic/ Palco/Cisco/Bosch</td>
</tr>
<tr>
<td>12.</td>
<td>Optical Fibre Cable</td>
<td>Extron/ Crestron/ Kramer/Amp/Belden</td>
</tr>
<tr>
<td>13.</td>
<td>HDMI / VGA Cable</td>
<td>Kramer/ Belden/ Klotz</td>
</tr>
<tr>
<td>14.</td>
<td>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>15.</td>
<td>Junction Box</td>
<td>ABB/L&amp;T/Havells/Schneider/Legrand</td>
</tr>
<tr>
<td>16.</td>
<td>Curtain Control Panels, Remote Control</td>
<td>Canara Lighting/ Effectron/ Stage Technologies</td>
</tr>
<tr>
<td>17.</td>
<td>RGY Laser</td>
<td>CT Lasers/ Canara Lighting/ Laser World</td>
</tr>
<tr>
<td>18.</td>
<td>Fog Machine, Metal gobos</td>
<td>Antari/ Canara Lighting/ Robe</td>
</tr>
<tr>
<td>19.</td>
<td>Fire Retardant Curtain, Plastic cyclorama screen</td>
<td>Omplie/ Raymond/ Mayur</td>
</tr>
<tr>
<td>20.</td>
<td>Lamps</td>
<td>Osram/ Philips/ GE/ Wipro</td>
</tr>
<tr>
<td>21.</td>
<td>DMX Signal Cable for DMX Network</td>
<td>Falcon/ Beldon/ Polycab/ Finolex</td>
</tr>
</tbody>
</table>

### Solid Waste Management System

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description</th>
<th>Make/Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Integerated Sterilizer with Shredder</td>
<td>Celitron / Ecodas / Cisa</td>
</tr>
</tbody>
</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.
# CHAPTER- T

## Technical Specifications- Medical Gas Pipeline System (MGPS)

<table>
<thead>
<tr>
<th>1</th>
<th>OXYGEN SUPPLY SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.1 LIQUID MEDICAL OXYGEN TANK (VACCUM INSULATED EVAPORATOR) AND ALLIED EQUIPMENTS APPLICATION:</strong></td>
<td></td>
</tr>
<tr>
<td>Storage of Liquid Oxygen and Supply of High purity Oxygen gas for medical use after conversion of liquid to gas through ambient atmospheric vaporizer.</td>
<td></td>
</tr>
</tbody>
</table>

**LIQUID MEDICAL OXYGEN STORAGE TANK:**

The double walled Vacuum Insulated Evaporator shall be constructed of stainless steel inner vessel contained within a carbon steel outer vessel. The annular space between the vessels shall be filled with non-inflammable perlite insulation material to insulate under vacuum. The VIE should be self pressurizing type by partial evaporation of liquid oxygen through a pressure building coil by a non ferrous imported pressure regulator. The vessel shall be supplied as a functional whole with all materials of construction & the cleaning regime suitable for medical grade liquid oxygen.

- **Quantity:** 20 KL X 1 No. and 10 KL X 1 No.
- **Installation:** Outdoor
- **Type:** Double walled, vertical
- **Capacity:** Minimum 20,000 liters water capacity - 1no.
  Minimum 10,000 litres water capacity - 1 No
- **Max. working pressure:** 17 Bar G
- **Design temperature:** $-196°C$ to $+50°C$
- **Hydraulic Test Pressure:** 26 bar G
- **Type of Insulation:** Vacuum, Perlite filled
- **Safety Valve Set pressure:** 17 Bar G (dual safety valve with three way diverter valve)
- **Bursting Disc Set Pressure:** 23 Bar G (Bursting disc)
- **Standard fittings:** Pressure rising coil, pressure building regulator of adequate capacity and size, dual safety valve with imported three way diverter valve, bursting disc., pressure gauges, liquid over flow line, Liquid level gauge and adequate numbers of extended spindle glove valve etc.
- **Maximum Evaporation Rate:** <0.35% of net value.
- **Material of Construction:** Inner shell and wetted parts of SS 304 Outer shell of CS ASTMA 516 Gr. 70 / CGA 341 2002 EN13455 S275/S355
- **Joint Efficiency:** 100%
- **Radiography:** 100% for inner, for outer spot
- **External piping:** From LMO Tank to Vaporizer SS304
  From Vaporizer to inlet of Pressure Reducing Station SS304
  From Outlet of Pressure Reducing Station to Main header Copper
- **Cryogenic Valves:** Non ferrous (Imported)
- **Cryogenic Safety Valves:** Imported
- **Pressure Building regulator:** Non ferrous
- **Leak Detection test:** Helium Leak detection
- **Painting:** Primer and finish with White RAL 9010
- **Inspection:** By 3rd party (SGS/LLOYDS/TUV)
- **Cleaning:** Degreasing for Oxygen Service and Pressurize with Nitrogen.
- **Withdrawal rate:** 1000 cum per hr. at 12 Bar G

**ACCESSORIES:**

- LMO Tank alongwith P&ID shall be fitted with the following accessories:
  - Top Fill Valve
  - Bottom Fill Valve
  - Liquid charging line blow valve
  - Liquid Delivery Valve
  - Overflow Valve
  - Gas blow valve
  - Filling Coupling
### Specification of Components

<table>
<thead>
<tr>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaporizer Coupling</td>
</tr>
<tr>
<td>Liquid Level Gauge (Dial 100 mm)</td>
</tr>
<tr>
<td>High Level Valve</td>
</tr>
<tr>
<td>Equalizing Valve</td>
</tr>
<tr>
<td>Low level Valve</td>
</tr>
<tr>
<td>Pressure Gauge (100mm dial, Range 0-25 kg/cm²)</td>
</tr>
<tr>
<td>Pressure Gauge Isolation Valve</td>
</tr>
<tr>
<td>Pressurizing Valve</td>
</tr>
<tr>
<td>Pressurizing Coil</td>
</tr>
<tr>
<td>Filter</td>
</tr>
<tr>
<td>Pressure Regulator</td>
</tr>
<tr>
<td>Economizer</td>
</tr>
<tr>
<td>Check Valve</td>
</tr>
<tr>
<td>Evacuation Port</td>
</tr>
<tr>
<td>Vacuum Gauge Connection Port/vacuum probe valve</td>
</tr>
</tbody>
</table>

#### SAFETY FITTING:
- Two safety valves for inner vessel fitted on pipeline with flow divert valve
- Rupture disc for inner vessel.
- Safety valve for inlet pipeline.
- Safety valve for pipeline of pressurizing evaporator.
- One rupture disc/safety device on outer vessel.

#### SUBMITTALS:
- The Liquid Medical oxygen tank shall accompany the Original Quality Test Certificate covering following Documents:
  - Approval letter from CCOE along with approved drawing from CCOE.
  - Approval letter from CCOE for use of cryogenic vessel(s) at site.
  - Certificate from the authorized inspection agency.
- Heat chart for pressure parts.
- Dimension checks report.
- Dished End reports.
- Mechanical properties test report for production test coupon.
- Visual inspection report.
- Radiography examination report.
- Liquid penetrant examination.
- Cleaning inspection report.
- Hydro-pressure test report.

#### Liquid Oxygen supply system
- One vessel of 1X20 KL Liquid oxygen VIE vessel system will be the primary (main) supply source and another vessel of 1X10 KL will be secondary source. In case of failure in liquid oxygen supply, it should automatically switch over to an emergency oxygen manifold having 2 X 20 cylinders.
- Design should be state-of-the-art.

- The unit should consist of a double walled vertical vessel (inner pressure vessel made of stainless steel and outer vessel of carbon steel). It should be fitted with standard accessories and should be “passed” the standard inspection requirement at factory for VIE. The copy of the certificate should be forwarded to HLL prior to shipping and original should be enclosed along with the shipping document. Bidder should follow international Standards.

#### Product and Service Specification:
- Proposed capacity of the primary liquid oxygen storage tank is 20X1 KL and secondary is 10 KL.
- Gas outlet pressure to be maintained at 4.2 kg/cm².
- Space taken for installation should be as per regulations of Indian explosive controller and having easy access for LMO tank.
- The site would be protected by fence around, well lit by sodium vapour lamps and demarcated with proper signage.
- Indication of liquid oxygen level and outlet gas pressure should be provided.
- Automatic change over should be provided between the primary and secondary LMO tanks. In case of failure in liquid oxygen supply, it should automatically switch over to an emergency oxygen manifold having 2 x 20 cylinders.
Product: The liquid medical oxygen (LMO) supplied at site should be of IP grade. The LMO supplied should comply with all relevant SMPV regulations and standards under the preview of the Indian Drugs and Cosmetic Act rules. They should also satisfy the IP 2007 specifications.

Storage Tank Specifications
The storage tank and the vaporizer coils should be designed as per the ASME Sec.VIII Div.1 latest Edition / EN-13485-2 Annexure-C/ AD2000, MARKBLATTER 2004 Edition.

The cryogenic vessel will be of cylindrical shape with vaporiser and the pressure control system. It should be provided with the essential components to fill the liquid, to build up pressure, to relieve pressure, to withdraw product and to evacuate the vessel. All protective, safety and alarm provisions mandatory to Liquid Medical Oxygen plants should be supplied.

The requirement of the Cryogenic Vessel should be:
1. Configuration: Vertical
2. Inner vessel maximum allowable working Pressure: 17 kg/cm²
3. Inner vessel hydrostatic test pressure: Greater than 26 kg/cm²
4. Outer vessel material of construction: Carbon steel
5. Inner vessel material of construction: Stainless steel
6. Independent AV coil should be provided with each vessel.

Storage Tank Capacity
Vacuum insulated evaporator vessel should have a capacity of 20X1 kilo liters and other with 1X10 kilo litres. The AV coil should have adequate capacity to handle the gas flow requirements of the hospital.

Vaporiser Coil
1. Maximum operating Pressure: 20 kg/cm²
2. Design Pressure: 22 kg/cm²
3. Pneumatic test Pressure: Greater than 24 kg/cm²
4. Inlet temperature: -196 to +40°C
5. Duty cycle: Continuous duty
6. Flow rate: 1200 cubic metre/hour

The fence, foundation, lighting, signage, approach gate etc are to be designed and installed by the vendor.

Safety
The vendor should ensure that all international safety norms and standards applicable as implemented and certified by the CCE.

Following are the mandatory provisions for vessel:
- Vessel low liquid level alarm
- Vessel low pressure alarm
- Pipeline low pressure alarm
- Twin regulator
- Twin safety valve
- Non return valve and 3 way diverter (bypass) valve
- Automatic changeover to manifolds with control panel
- Alarm on indicating manifold in use in case the vessel is not in use.
- Alarm on low pressure back-up manifold cylinders

Statutory Requirements
All statutory requirements of the Chief Controller of Explosives of India and SMPV rules need to be followed, besides all regulations and guidelines put forward by the Govt. Of India from time to time should be followed.

Maintenance
All routine preventive maintenance and break-down maintenance of the liquid oxygen plant should be done by the vendor. Experienced personnel should be readily available.

Log of all works undertaken in the plant should be meticulously maintained by the vendor.

Bulk cylinders for the manifold will be arranged by the hospital. The hospital will ensure that the cylinders are full and ready to use during emergencies.

2 Oxygen Manifold Supply System
2.1 Fully Automatic Oxygen Control Panel
Automatic control panel should be constructed in accordance with the requirement of international standards. The fully automatic oxygen control panel should comply with HTM 02-01/NFPA 99C/DIN/EN/ISO-7396-1 standards. It should be US FDA / European CE Certified with 4 digit
notified body number or American ETL/ American UL listed.

The manifold assembly should provide two stages of pressure regulation. A single stage primary regulator, one for each cylinder bank should be used to initially reduce cylinder pressure and two single stage pressure regulators should be provided in the control cabinet for final delivery pressure regulation. One delivery pressure regulator in service and one should be ready for service in a standby mode. **The Manifold control panel should be with digital display,** fully automatic type and switches from “Bank in Use” to “Reserve bank “ without fluctuation in delivery supply line pressure. Changeover should be performed by electrically/pneumatically operated valves contained in the control cabinet. In the event of an electrical power failure the valves should automatically open to provide an uninterrupted gas flow. It should be 100% automatic and should not require manual adjustment.

**Indication for changing the cylinders should be clearly identified on the front of the control panel.**

All functional components should be enclosed in corrosion resistant robust material.

All components inside the Control Panel like Pressure Regulators, piping and control switching equipment should be cleaned for Oxygen Service and installed inside the cabinet to minimize tampering with the regulators or switch settings.

**The Control Panel shall include two pressure relief valves, one high pressure approx. 200/350psi and one low pressure approx.75 psi.**

The heavy duty control panel should be provided with a flow capacity of 1500 or more LPM at 50 to 60 psi.

The Automatic Control Panel should be installed in such a way to meet the peak flow requirement of the Hospital/Institute (If the requirement is more than flow capacity requirement automatic control panel the bidders has to supply 02 numbers of Automatic Control Panel and design the system in such a way to meet the flow requirement of respective institute) Control panel should have Alarm reset switch/Mute /acknowledgement switch to control and monitor the alarm indications by the operator.

### 2.2 Oxygen Manifold Supply System

**The O2 Manifolds size should be minimum 20 x2 compatible with Class-D type bulk cylinders**

Manifold shall consist of two high pressure header bar assemblies to facilitate connection of primary and secondary cylinder supplies. Each header bar shall be provided with respective numbers of cylinder pigtail connections to suit cylinder valves as per IS.3224/ BS/ ASME incorporating a check valve at the header connection.

Each header bar assembly shall be provided with a high pressure shut off valve.Oxygen Manifold should consist of 2 rows of respective numbers of class D-type bulk oxygen cylinders. The manifold should be hydraulically tested to 3500 psig. The manifold should be so designed that it shall suit easy cylinder changing and positioning. The system should have non – return valves for easy changing of cylinders without closing the bank. The cylinder should be placed with the help of cylinder brackets and fixing chains which should be galvanized.

### 2.3 Emergency Oxygen Manifold

**The Emergency O2 Manifolds should be minimum 10x2 or 20x1 compatible with Class-D type bulk cylinders**

Manifold shall consist of two high pressure header bar assemblies to facilitate connection of respective numbers of primary and secondary cylinder supplies. Each header bar shall be provided with respective numbers of cylinder pigtail connections to suit cylinder valves as per IS.3224/ BS/ ASME incorporating a check valve at the header connection. Each header bar assembly shall be provided with a high pressure shut off valve.

Oxygen Manifold should consist of 1/2 rows of respective numbers of class D-type bulk oxygen cylinders. The manifold should be hydraulically tested to 3500 psig. The manifold should be so designed that it shall suit easy cylinder changing and positioning. The system should have non – return valves for easy changing of cylinders without closing the bank. The cylinder should be placed with the help of cylinder brackets and fixing chains which should be galvanized.

### 3 Oxygen Flow meter with Humidifier Bottle

**Back Pressure Compensated flow meter for accurate gas flow measurement with following features:**

A) Control within a range of 0-15 LPM.

B) It should meet strict precision and durability standard.

C) The flow meter body should be made of brass chrome plated materials.

D) The flow tube and shroud components should be made of clear, impact resistant polycarbonate.

E) Flow tube should have large and expanded 0-15 LPM range for improved readability at low
flows.

F) Inlet filter of stainless steel wire mesh to prevent entry of foreign particles

G) The humidifier bottle is made of unbreakable & reusable polycarbonate / polysulfone material autoclavable at 121 degree centigrade.

H) Humidifier Bottle should be covered under warranty & CMC.

I) Should be BIS/CE certified/ UL Listed

4 NITROUS OXIDE SYSTEM

4.1 Fully Automatic Nitrous Oxide Control Panel

The fully automatic N2O control panel should comply with HTM 02-01/ NFPA 99 C/ EN / DIN / ISO 7396-1 STANDARD. It should be US FDA / European CE Certified with 4 digit notified body number or American ETL/ American UL listed.

The manifold assembly should provide two stages of pressure regulation. A single stage primary regulator, one for each cylinder bank should be used to initially reduce cylinder pressure and two single stage pressure regulators should be provided in the control cabinet for final delivery pressure regulation. One delivery pressure regulator in service and one should be ready for service in a Standby mode. The Manifold control panel should be digital, fully automatic type and switches from “Bank in Use” to “Reserve bank” without fluctuation in delivery supply line pressure. Changeover should be performed by electrically/pneumatically operated valves contained in the control cabinet. In the event of an electrical power failure the valves should automatically open to provide an uninterrupted gas flow. The manifold should not require any manual resetting or adjustments after the replacements of the depleted cylinders.

The Control Panel shall include two pressure relief valves, one high pressure approx. 200psi and one low pressure approx. 75 psi.

The control panel should also have heaters to prevent ice formation on the regulators at high flow rates.

The Control Panel should be made to provide Heavy Duty and have a flow capacity of 500 LPM or more at 50 to 60 psi.

The Automatic Control Panel should be installed in such a way to meet the peak flow requirement of the Hospital/Institute. (If the requirement is more than flow capacity requirement automatic control panel the bidders has to supply 02 numbers of Automatic Control Panel and design the system in such a way to meet the flow requirement of respective institute).

Control panel should have Alarm reset switch / Mute / acknowledgement switch to control and monitor the alarm indications by the operator.

4.2 Nitrous Oxide Manifold

The size of Manifolds should be 2x8 as primary source compatible with Class-D type bulk cylinders.

Manifold shall consist of two high-pressure header bar assemblies to facilitate connection of primary and secondary cylinder supplies. Each header bar shall be provided with respective number of cylinder pigtail connections to suit cylinder valves as per IS 3224/ BS/ ASME incorporating a check valve at the header connection. Each header bar assembly shall be provided with a high pressure shut off valve. The manifold should be hydraulically tested to 3500 psig. The manifold should be so designed that it shall suit easy cylinder changing and positioning. The cylinder should be locked with the help of cylinder brackets and fixing chains which should be galvanized.

4.3 Emergency N2O Manifold

The size of Manifolds should be 2x4 as emergency source compatible with Class-D type bulk cylinders.

Manifold shall consist of two high-pressure header bar assemblies to facilitate connection of primary and secondary cylinder supplies. Each header bar shall be provided with respective numbers of cylinder pigtail connections to suit cylinder valves as per IS 3224/ BS/ ASME incorporating a check valve at the header connection. Each header bar assembly shall be provided with a high pressure shut off valve. Nitrous oxide manifold should consist of 2 rows of respective numbers of cylinders.

The manifold should be hydraulically tested to 3500 psig. The manifold should be so designed that it shall suit easy cylinder changing and positioning. The system should have non-return valves for easy changing of cylinders without closing the bank. The cylinder should be placed with the help of cylinder brackets and fixing chains which should be galvanized.

5 CARBON DIOXIDE MANIFOLD SYSTEM

The system should consist of medical CO2 Manifold 2x4 Primary & 2x2 Standby with Class-D type
Cylinders and control panel. Control panel of CO2 should be US FDA / European CE Certified with 4 digit notified body number or American ETL/ American UL listed.

The Modular Manifold supply system shall provide carbon dioxide piped distribution system.

The Modular Manifold system should be in such a way that it increases flexibility and allows easy enlargement of the manifold capacity in case of future expansion. Should be complies with HTM 02-01/ NFPA 99 C/EN/DIN/ ISO 7396-1 standard.

Fully Automatic Control panel for CO2 System

The Manifold Control System should supply any type of medical gas from both left and right hand manifold banks. Operation and performance criteria should fully satisfy the requirements of HTM 02-01/ NFPA 99 C/EN/DIN/ ISO 7396-1 standard. The fully automatic CO2 control panel should comply with the standard. It should be US FDA / European CE Certified with 4 digit notified body number or American ETL/ American UL listed.

The Manifold Control System shall supply on uninterrupted flow of 500 L/min. to a 400 k Pa (4 bar) distribution system. Either the left or right hand manifold bank may be designated "Duty" and should automatically changeover to supply the distribution system from the "Standby" bank when pressure in the "Duty" bank falls to a predetermined level.

6 Medical and Surgical Air System (Package Unit)

Air-cooled Oil-Less compressors for continuous duty application with highest output of compressed air, low power consumption and very low vibration resulting in low noise level.

The medical air plant shall fully comply with the requirements of the HTM 02-01/ NFPA 99 C/EN/DIN/ISO 7396-1. It should be US FDA / European CE Certified with 4 digit notified body number or American ETL/ American UL listed (Incase of NFPA 99c the control panel of plant must be UL/ETL Listed and Undertaking from manufacturer for this tender reference must be submitted for using the same control panel in the system offered)

6.1 Air Compressor Modules

It should be Oil-Less Screw Compressors /Scroll Compressors to produces the plant output of minimum capacity of 9000 LPM as Primary & 2000 LPM as standby or Total minimum Plant Capacity of 11000 LPM with minimum 4500 L Tank.

Medical quality air shall be delivered at a nominal pressure of 400 kPa (4 bar) and 700kPa(7 bar) gauge for supply of the hospital medical air and surgical air.

Compressor plant should be designed in such a way that compressors will switch on in a sequential manner as per flow demand.

The compressors should be standalone ones with independent power supply. Each Compressor should be suitable for both continuous and frequent start/stop operation at a nominal plant pressure of 10bar or more.

The duty compressors shall be automatically rotated by the plant control system to ensure even wear. Compressors shall be supplied and installed. Desiccant dryer shall be provided with a dew point sensing switch that shall provide an alarm on the plant control panel and central hospital alarm system when the water concentration in the delivered air rises above the limit. Duplex desiccant dryer and filtration modules shall be provided with three or more individual stages of filtration as follows:

Stage 1: Coalescing filter upstream of the desiccant dryer for removing liquid water particles down to 1micron.
Stage 2: Particulate filter after the desiccant dryer for dust protection and removing particles down to 1 micron.
Stage 3: Bacteria filter for removing particles down to 0.01 micron.

Purity should be tested as per the American Pharmacopeia / European Pharmacopeia standard.

The plant control and power management system shall monitor the safe operation of the plant, providing signal into the alarm system as per the requirements of the standard.

Pressure Reducing Station: for 4 bar and 7 bar should fully comply and meet with the requirements of the standard. Simplex pressure reducing station shall comprise as in-line pressure regulator, with downstream pressure gauge. Isolation valves and pressure release valves should be provided as per the standard. Duplex pressure reducing station to have two branches, connected to the MGPS in parallel in order to allow maintenance on the components of one branch, while the gas flow is maintained in the other branch. Ball Valves - Full bore which operate from fully open to fully closed position with a quarter turn of the handle. Complete pressure reducing station with base plate mounted for ease of installation.

Padlocks available to allow locking of the valves in both open and closed positions and must have easy to read pressure gauges. Base plate mounted and supplied with copper stub pipes for ease
of installation using inert jointing procedures.

The compressor system should have-

**Intake filter**

- Mounting on air tank along with all standard fittings viz. safety valve, pressure gauge, delivery valve, drain valve etc.

- Bidder shall provide all electric control panels, starters etc required for proper functioning of motor.

- Desiccant Air Dryer – 2 nos.(Duplex)

- 2-Stage or more Breathing Air Filters – 2 sets(Duplex)

- Outlet pressures for drills/equipment and ventilators should be a minimum of 7 bar and 4 bar respectively.

- Duplex pressure reducing station

  - The compressor should be heavy duty, reliable with long MTBF. Each compressor cylinder is to be protected by a temperature switch, which will stop the drive motor and provide an alarm signal in the event of abnormal discharge air temperature. Each compressor module should include an inline filter with particle retention of 10 microns, inlet isolation valve, discharge isolation valve, and pressure relief valve. The capacity should be capable to take care of total load of all the outlets.

6.2 **Vertical Air Receiver**

- Total air receiver capacity shall be at least 50% of the primary plant capacity (capacity as mentioned) in 1 minute in terms of free air delivered at normal working pressure. Each air receiver shall be protected by a pressure relief valve, a fusible plug and include a pressure gauge with isolating valve and a drain cock.

  - The corrosion resistant coated receiver is to be equipped with tested safety pressure relief valve, sight glass pressure gauge, automatic drain, three-valve by-pass and source isolation valve. Should be fabricated as per ISO/ASME/BS

6.3 **Air Treatment Module**

- The air treatment module should include dual dryers, dual filtration system and a dewpoint transmitter with local audible and visual signals and dry contacts for remote monitoring. The components should be mounted on a common base with interconnecting copper/brass piping and upstream and downstream isolation valves. The isolation valves must allow either set of components to be serviced without shutting down the system.

  - Dryers should be of heatless desiccant design and sized to provide for the peak calculated demand. The desiccant dryers should be equipped with dew point dependent switching feature to minimize the need for purge air.

  - The dual filtration system should remove liquid and particulate matter, consisting of 0.5micron coalescing filters with differential pressure indicators and automatic drain, airline pressure regulators with gauges, final pressure relief valve, and sampling valve.

  - Each bank should consist of three stage treatment. Digital dew point monitor is to be supplied with alarm contacts as per requirement of the standard.

6.4 **System Controls**

- The "Continuous on Demand" feature will stop the operation of the motors during periods of low or no demand. The control include individual self-protected combination motor controls with short circuit protection, single phase and thermal overload protection, individual control circuit with transformers primary and secondary protection, pressure sensors, temperature switches with reset buttons, and an electronic controller to automatically change the operating sequence of the compressors. The cabinet shall have status display to include system pressure, dew point pump operation, accumulated time, maintenance interval, fault conditions, and silence button, lighted Hand-Off-Automatic selector switches and safety disconnect operating handles. All required local alarm functions shall be integrated in to the packaged system.

  - The system should be designed to function even if the programmable controller fails.

6.5 **Accessories**

- Accessories including for job site installation such as inlet and discharge flexible connectors, vibration mounting pads, and source isolation valve should be supplied.

  - All the filters should be covered under warranty period and CMC Period.

7 **VACUUM SYSTEMS (Package unit)**

- It should be US FDA / European CE Certified with 4 digit notified body number or American ETL/ American UL listed (In-case of NFPA 99c the control panel of Plant must be UL/ETL Listed and Undertaking from manufacturer must be submitted for using the same control panel in the system offered)and should comply with HTM 0201 / NFPA 99 C / EN /DIN/ISO 7396-1
### 7.1 Vacuum Pump Module

**It should be Oil Sealed Rotary Vane Type to produces the plant output of minimum capacity of 6000 LPM as primary and 6000 LPM as standby with minimum 6000 L of tank.**

- Designed flow capacity should be minimum of LPM capacity as mentioned in BOQ of respective institute. The vacuum plant shall comprise air-cooled, oil lubricated rotary vane vacuum pumps suitable for both continuous and frequent start/stop operation at inlet vacuum levels between 500mmHg and 660 mmHg.
- The control system should normally employ automatic rotation of the lead pump to maximize pump life and ensure even wear. Vacuum pump inlets shall include a wire mesh filter and integral non-return valve to prevent oil suck back and pressure increases in the vacuum system.
- Each vacuum pump shall be fitted with anti-vibration pads between the pump foot and mounting frame. The plant shall be fitted with duplex bacteria filter system.

### 7.2 Vacuum Receiver

- The vacuum receiver shall be made of rust free corrosion resistant steel and fabricated as per ASME/BS/ISO for a vacuum pressure of 760mmHg. It should include bypass valves, manual drain valves, vacuum gauge. Vacuum reservoir shall have total volume of at least 100 % of primary plant output (capacity as mentioned) in one minute in terms of free air aspirered at normal working pressure.

### 7.3 System Controls

- The control include individual self-protected combination motor controls with short circuit, single phase and thermal overload protection, individual control circuit transformers with fuse less primary and secondary protection, pressure sensors, temperature switches with reset buttons, and an electronic controller to automatically change the operating sequence of the compressors. The system should have a status display to show the system pressure, elapsed time, maintenance interval, fault conditions, and silence button, lighted Hand-Off-Automatic selector switches and safety disconnect operating handles.
- All required local alarm functions should be integrated into the packaged system. The circuitry should be designed so that the audible signal can be silenced and the visual indicator will remain until the fault has been cleared and the reset button resets. Local alarm functions should be annunciated for reserve pump in use.

### 7.4 Bacterial Filters

- The filters should be designed for removal of solid, liquid and bacterial contamination from the suction side of vacuum pump systems, preventing damage to the pump and the potential biological infection of the surrounding environment. The dryer should be particulate filter dryer with ability to remove particles as small as 1 micron.
- Each individual filter shall have the capacity to deliver full design flow such that one set is designated duty and the other will be standby. Bacteria filters shall have efficiency at least 99.999% when tested by the sodium flame method in accordance with BS 3928:1969/as per required standard utilising particles in the 0.02 to 2 micron size range. The pressure drop across each clean filter at 50% of the system design flow should not exceed 25 mm Hg (3 kPa) at a vacuum of 475mm of Hg (63 kPa). Bacteria filters shall be marked with the legend ‘Bio-Hazard’.
- Each bacteria filter shall be provided with a transparent sterilizable collection jar to collect condensate. The total water capacity of the pressure vessels shall be at least 100% of the design flow rate of the plant in 1 minute in terms of free air aspirered.

### 7.5 Accessories

- Accessories included for job site installation are inlet and discharge flexible connectors, vibration mounting pads, and source isolation valve, inlet check valve, thermal malfunction switch and vacuum control switch. Flexible connectors on inlet and exhaust of each pump, exhaust tee with union as well as copper tubing with Shutoff- cock for gauge/bypass valve and vacuum switch etc.

### 8 Vacuum Units (Ward/Theaters/Low Flow)

#### 8.1 Ward Vacuum Units:

- 1no of Suction Regulator and 1no of 1000 ml polysulfone /polycarbonate collection jar.

**Digital Suction Regulator:** Suction regulator should be supplied with a safety jar, including and antibacterial filter and an anti-overflow safety device. Should have wide membrane continuous suction controller

- Should have vacuum levels: 0-750 mm Hg or more

- Should have vacuum gauge fitted with a protective bumper device.

- Should have on/off knob allowing for the quick restoration of a readjusted vacuum level.
Must have central adjustment knob with a color coded for 0 to 750 mm Hg or more. Should have Polysulfone/ polycarbonate 100cc safety jar, autoclavable at 121°C at 5mins, unbreakable, fitted with an anti-overflow safety device and equipped with antibacterial filter. It should be totally transparent, to ensure perfect sucked liquid visibility.

8.2 Low flow ward vacuum unit - Should have vacuum levels: 0-250 mm of Hg +/-10%

8.3 Theatre Vacuum unit for OT

Digital Suction Regulator and 2nos. 1500ml or more polysulfone/ polycarbonate collection jar and both to be mounted on a trolley.

Suction Regulator: Suction regulator should be supplied with a safety jar, including an anti-bacterial filter and an anti-overflow safety device. Should have wide membrane continuous suction controller

Should have vacuum levels: 0-750 mm of Hg or more

Should have vacuum gauge fitted with a protective bumper device.

Should have on/off knob allowing for the quick restoration of a readjusted vacuum level.

Must have central adjustment knob with a color coded for 0-750 mm Hg or more. Should have polysulfone/ polycarbonate safety jar, autoclavable at 121°C, unbreakable, fitted with an anti-overflow safety device and equipped with antibacterial filter.

Collection jar should be totally transparent, to ensure perfect sucked liquid visibility.

9 AGSS (Anesthetic Gas Scavenging System) System (Package Unit)

Anesthetic Gas Scavenging System (AGSS) of minimum 2500 LPM as Primary & 2500 LPM as Standby. It should be US FDA / European CE Certified with 4 digit notified body number or American ETL/ American UL listed (In case of NFPA 99c the control panel of Plant must be UL/ETL Listed and Undertaking from manufacturer must be submitted for using the same control panel in the system offered) and should comply with HMT 02-01 / NFPA 99 C/EN/ISO 7396-1.

The package should consist of rotary vane/claw type vacuum pumps (Dry/Oil less only), a control panel, and mounted on a common base frame.

AGSS pump: AGSS pump shall operate completely dry. Each pump should be completely air cooled and have absolutely no water requirements. The suitable wiring from OTs to AGSS plant for remote control/suitable reservoir (as applicable) is the responsibility of the bidder.

System in-line non-return valves should allow individual pump servicing. Active anesthetic gas scavenging systems should be designed to safely remove exhaled anesthetic agents from the operating environment and dispose of them to atmosphere from the highest point of the hospital building, thus preventing contamination of the operating department and providing a safe and healthy workspace for the personal. AGSS design should be dependent upon flow rate and pressure drop characteristics of the individual components of systems. It is essential that terminal units, remote controls (If required) and pump units work in synchronized manner after connection of workstation to the AGSS System.

Installation should be on roof top/suitable location. Piping, Non-Return-Valves (NRVs), and inlet nozzle should be suitably placed. Connecting hose suitable to fit with anesthesia workstation should be provided.

10 DISTRIBUTION PIPING

10.1 Piping specifications

Copper pipe should be as per standard BS: EN 13348:2008/ ASTM B819 standards, Solid drawn, seamless, deoxidized, non-arsenical, half hard (hard can be accepted only for sizes 54mm or more), tempered and degreased copper pipe conforming to the standard. All copper pipes should be degreased & delivered capped at both ends. The pipes should be accompanied with manufacturers test certificate for the physical properties & chemical composition.

Copper pipe must have reputed third party inspection certificate (Eg. Lloyd’s or TUV or SGS).

Fittings should be made of copper and suitable for a working Pressure of up to 17bar and especially made for brazed socket type connections. All valves shall be pneumatically tested for twice the working pressure and factory degreased for medical gas service.

Copper fittings should comply with EN 1254:1 factory degreased and brazing filler metals should comply with EN 1044. Fitting should be degreased, individually packed for medical use.

The minimum thickness of copper pipes of 35mm and above outer diameter, should be 1.2mm and the thickness of copper pipes less than 28mm outer diameter, should be 1mm as mentioned in respective Institute’s BOQ.

10.2 Installation & testing

Installation of piping shall be carried out with utmost cleanliness. Only pipes, fittings and valves that have been degreased and fittings shall be used at site. Pipe fixing clamps shall be of nonferrous or non-deteriorating plastic suitable for the diameter of the pipe.
Inert gas welding technique should be used by passing oxygen Free Nitrogen Gas inside the copper pipes during silver brazing, in order to avoid carbon deposition inside the copper pipes. Only copper-to-copper joints are permitted on site except threaded or flanged joints may be made where pipelines are connected to items such as valves and control equipment. No flux shall be used for joining Copper to Copper joints and on for joints made on site. Copper to copper joints shall be brazed using a 5% silver-copper phosphorous brazing alloy CP104. A total of 5 joints shall be cut out for examination to establish the quality of the joints being made on site. The insides shall be clean and free from oxides and particulate matter and the minimum penetration of the brazing alloy at any point shall be three times the wall thickness of the tube. If the joints examined do not conform to these requirements, then adjacent joints shall be cut out and examined until the extent of faulty workmanship has been made good. Copper-to-brass or gunmetal joints shall only be made under controlled conditions off site. The joints are ordinarily used to join short copper pipe tails to brass, gunmetal or bronze fittings to permit their connection into the pipeline. The sub-assemblies shall be degreased and individually sealed in bags or boxes before delivery to site.

Suitable sleeves shall be provided wherever pipes cross through walls / slabs. All pipe clamps shall be non-reactive to copper. After erection, the pipes are to be flushed with dry nitrogen gas and then pressure tested with dry nitrogen at a pressure equal to twice the working pressure or 150 psig, whichever is higher for a period of not less than 24 hours.

Length and quantity of individual items (Copper pipes, AVSUs, Alarm panels, Isolation valves, Outlets, pendants etc.) are mentioned. However quantity will be calculated and paid at actuals. Bidder should quote unit price for all the items as detailed.

Maximum interval between supports (Horizontal and Vertical)

- 12mm Pipe - 1.5m
- 15mm pipe - 1.5m
- 22mm pipe - 2m
- 28mm pipe - 2m
- 35mm pipe - 2.5m
- 42mm pipe - 2.5m
- 54mm pipe - 2.5m
- 76mm pipe - 3m

10.3 Painting

All the pipes from manifold/plant upto the outlets should be painted with two coats of synthetic enamel paint and colour codification should be as per standards followed and with consultation with competent authorities of the Institute.

11 GAS OUTLETS

Terminal Units (Gas Outlets) with probes/Adaptors for O2, N2O, Compressed Air 4, Air 7, AGSS, Vacuum & CO2 (CO2 can be optional depending on the requirement)

The Medical gas outlets shall confirm to HTM 02-01/ NFPA 99 C/EN/DIN/ ISO 7396-1. Front Loading Type Terminal Outlets should be designed to dispense medical gases (or an inlet for medical vacuum) to the secondary equipment (flow meters, Suction regulators, etc.) at the point of use and is gas specific so that secondary devices cannot be "attached" to the wrong gas. When not in use the gas in a non-flowing state within the Outlet (Terminal unit) sealed by "O" ring. The adapter when inserted pushes the poppet inside and the gas starts flowing and sealing is ensured by the "O" ring or a seat. The Outlets are Quick Connect Type and gas specificity is accomplished by "Pin indexing." The outlets should have following features:

- Push to insert and press-to-release mechanism for probes.
- Allows plugging of probes from front.
- Self-sealing valve on disengaging the probe (Quick disconnect)
- Smooth quite action.
- Non return valve for on line servicing/ repairing
- Indexed to eliminate inter-changeability of gas services
- Color-coded gas specific front plate
- Totally leak proof, safe & easy to operate
- Configurations possible: surface, flush & Bead-head.

- Outlets should be US FDA / European CE Certified with 4 digit notified body number or American ETL/ American UL listed
- All outlets should have respective labels (i.e. O2 / N2O / CO2 / Air4 / Air7/Vacuum/AGSS/etc.) displayed accordingly.

12 AREA VALVE SERVICE UNIT

Area valve service units should fully comply and meet with HTM 02-01/NFPA 99C/EN/DIN/ISO7396-1. It should provide a zone isolation facility for use either in an emergency or for maintenance purpose The Area Valve Service Unit should incorporate a ball valve in a lockable box with emergency access. It should be reliable and easy to operate, easy purge,
sample & pressure testing and emergency supply system.

Medical gas/vacuum services should be fixed copper, piped to and from their respective area valve service units. A color coded service identity label should be fitted behind the valve handle. The unit should provide a zone isolation facility. Gas flow direction should be indicated.

The box shall be made from extruded aluminum to prevent corrosion. All wetted parts (except seals and gaskets) should be brass or copper. Each unit assembly should be factory tested for gas tightness. Rubber pipe grommets should be provided to ensure any leaking gas does not escape from the unit into a wall cavity. All visible aluminum surfaces should be powder coated.

**12.1 Line Isolation Valves**

The Lockable line valves must degreased and complete valve with stuffed pipe & fittings, factory tested and complies with HTM 02-01/ NFPA 99 C/EN/DIN/ISO 7396-1 standard.

<table>
<thead>
<tr>
<th>13 ALARM SYSTEM (Area &amp; Master)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>13.1 Master Alarm (Digital)</strong></td>
</tr>
<tr>
<td>Should be US FDA / European CE Certified with 4 digit notified body number or American ETL/ American UL listed.</td>
</tr>
<tr>
<td>Complies with HTM 02-01 / NFPA 99C/EN/DIN/ ISO 7396-1 Standards.</td>
</tr>
<tr>
<td>Each Master Alarm should be modular in design and be fitted with required number of master alarm modules. The master alarms should be capable to monitor minimum 40 Point.</td>
</tr>
<tr>
<td>Each point represents an alarm condition that the source equipment might have. When an alarm condition exists, a red light flashes and the audible alarm sounds. If several alarm conditions occur simultaneously, the most recent alarm light should flash, while the other alarm lights should remain lit. When an alarm condition is created, an audible alarm should be actuated. A dry contact module should be available to interface with a building management system.</td>
</tr>
<tr>
<td>The box material should be of gauge steel of requisite thickness and equipped with mounting brackets. The emissions from alarms should conform with EMC standards.</td>
</tr>
<tr>
<td>Master alarm management system should be designed to display alarm conditions from the source supply units indicating the broad status of the source equipment and manifolds as well as the master distribution status from the source supplies. Depending on the alarm priority, a visual and audible alarm should be initiated to indicate an alarm condition.</td>
</tr>
<tr>
<td>Each panel shall display and/or input up to forty point alarms. Panel should be ready to use with BMS system.</td>
</tr>
<tr>
<td>The master alarm must be able to monitor the following source alarm conditions.</td>
</tr>
<tr>
<td>· Oxygen Source Empty/Fault</td>
</tr>
<tr>
<td>· Oxygen Cylinder Bank Empty/Fault</td>
</tr>
<tr>
<td>· Oxygen Emergency Bank Empty/Fault</td>
</tr>
<tr>
<td>· Air Compressor Faulty/Operation</td>
</tr>
<tr>
<td>· Vacuum Pump Faulty/Operational</td>
</tr>
<tr>
<td>· Vacuum Deficiency Vacuum Reservoir</td>
</tr>
<tr>
<td>· And Other MGPS Signals &amp; Alarms</td>
</tr>
<tr>
<td>Bidder shall be responsible for all cabling from local alarm panels to master alarm panel for monitoring the alarm condition centrally.</td>
</tr>
<tr>
<td>Master alarm should be integrated with BMS/HIS</td>
</tr>
</tbody>
</table>

**13.2 Medical Gas Area Alarm (Digital)**

The medical gas central alarms should be capable of monitoring up to 5 medical gas services (As specified in BOQ of respective institute) by means of pressure sensors which detect deviations from the normal operating limits of either pressure or medical vacuum. The area alarm should have a digital display of pressures. The medical gas area alarm should fully satisfy the HTM 02-01/ NFPA 99 C/EN/DIN/ISO 7396-1 requirements and should be US FDA / European CE Certified with 4 digit notified body number or American ETL/ American UL listed.

An audible warning should sound simultaneously with any failure indication and a mute facility should be provided."

**Note:** The bidder may offer combined unit of AVSU & alarm but it should match the functional requirement of the technical specification.

Bidder shall responsible for LAN/Network cabling for syncronization of all Area Alarms and it should be monitored centrally. (Dedicated PC should be provided for digital alarm monitoring) this may be done through HIS also if possible.

**14 Horizontal/ Vertical Bed Head Panel**

It shall confirm to HTM 02-01/ NFPA 99 C/EN/DIN/ISO 7396-1. The design should be approved by the respective institute/HITES before installation and it is responsibility of the bidder after
getting order they have to discuss with respective institute/HITES and finalized the Bed Head Panel (Vertical/Horizontal) as per site condition. Color of BHP should match the intirior of the hospital building, the approval of the same should be taken from institute/HITES

**It should have following features:-**

- Efficient, Safe & Robust design in extruded aluminium section.
- Smooth curved surfaces, and choice of base colour and fascia plates.
- Unit should have integrated rail system to mount accessories
- The headwall system should be constructed of aluminium extrusions joined together to form a carcass to suit the particular application. Unit should be factory assembled for electrical and mechanical components.
- Segregation of services i.e. Low voltage supplies, High Voltage supply and Medical gases should be maintained with 2 tier/2 channel arrangements.
- Front fascia plate should be removable individually to access for respective service.

**It should have one rail for mounting Accessories.**

Each bed-head unit shall be supplied with electrical and electrical outlets pre-fitted, wired and certified. (Wired up to the distribution box provided with leakage protection & proper earthing arrangements)

**Configuration will be as under for each bed head panel**

for Private Room & Isolation Room/Special Ward(like- Dialysis,etc) (On BHP): O2-1, Vc-1 and MA4-1

for ICU/CCU Bed (on BHP) : O2-2, Vc-2 & MA4-2

for Pre-Op Bed (on BHP) : O2-1, Vc-1 & MA4-1

for HDU/Post-Op Bed (on BHP) : O2-2, Vc-2 & MA4-1

for Minor OT/Cath Lab/CT/LINAC/Etc (On BHP): O2-2, Vc-2, MA4-1, N2O-1

for Endoscopy/Etc : O2-1, Vc-1 , MA4-1, CO2-1, N2O-1

Infusion pump mount pole with adapter for mounting at least two infusion pumps on each BHP

5 /15A combined Electrical outlets – 8 Nos. or more on each BHP

RJ-45 socket/ Ethernet -01 on Each BHP

Two spare spaces on Each BHP

Monitor Bracket on Each BHP

15 **High pressure tubes for O2, N2O, CO2, AGSS, Compressed Air & Vacuum, Etc.**

It should be colour coded for individual services i.e. white for Oxygen, Blue for N2O and Yellow for Vacuum. Black for air. Antistatic rubber tube should be as per ISO standards. It should be CE marked/UL Listed. Hose- Gas wise requirement should be taken on the basis of outlet installed and 50m of each service should provide for institute stock for future uses.

16 **Electrical Wiring & Requirements –**

All wiring inside the Manifold Room and Plant room required for MGPS equipment and General electrification and ventilation. All the work should be as per BIS/CE standard and material used should be reputed make only. Plant room should be Air Conditioned with adequate capacity as the plant will run for 24x7 the suitable backup AC should be also considered. Wiring (LAN & Electrical) for MGPS alrams should be also done and it should be on UPS supply only. All the MGPS Plants, Manifold and LMO electrical supplies should be backedup with DG supply. All the necessary wiring of LMO Tank area as per requirement will be done according to standard.
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description /items</th>
<th>Approved makes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LMO Tank (20KL Primary Supply and 10KL Backup Supply)</td>
<td>Linde / Prax Air / Inox</td>
</tr>
<tr>
<td>2</td>
<td>Secondary Oxygen Manifold and Emergency oxygen manifold with automatic control panels</td>
<td>Atlas Copco / Amico / Ohio Medical / pneumatic berlin</td>
</tr>
<tr>
<td>3</td>
<td>Oxygen Flow meter with Humidifier Bottle</td>
<td>Atlas Copco / Amico / Ohio Medical / pneumatic berlin</td>
</tr>
<tr>
<td>4</td>
<td>Nitrous Oxide Manifold and Emergency NO2 Manifold with automatic control panel</td>
<td>Atlas Copco / Amico / Ohio Medical / pneumatic berlin</td>
</tr>
<tr>
<td>5</td>
<td>Co2 Manifold and Emergency Co2 Manifold with automatic control panel</td>
<td>Atlas Copco / Amico / Ohio Medical / pneumatic berlin</td>
</tr>
<tr>
<td>6</td>
<td>Medical Air Supply System (4 Bar &amp; 7 Bar) complete.</td>
<td>Powerex / Atlas Copco / Amico / Ohio Medical / pneumatic berlin</td>
</tr>
<tr>
<td>7</td>
<td>Medical Vacuum (suction) Supply System Complete.</td>
<td>Powerex / Atlas Copco / Amico / Ohio Medical / pneumatic berlin</td>
</tr>
<tr>
<td>8</td>
<td>Vacuum Units (Ward/Theaters/Lowflow)</td>
<td>Atlas Copco / Amico / Ohio Medical / pneumatic berlin</td>
</tr>
<tr>
<td>9</td>
<td>AGSS system Complete</td>
<td>Powerex / Atlas Copco / Amico / Ohio Medical / pneumatic berlin</td>
</tr>
<tr>
<td>10</td>
<td>Distribution Piping Complete with Accessories.</td>
<td>Copper Pipe : Mehta Tube(Maxflow) / Rajco / Metal Alloys (Metalco) Fittings : Conex Banninger</td>
</tr>
<tr>
<td>11</td>
<td>Gas Outlets with Probes</td>
<td>Atlas Copco / Amico / Ohio Medical / pneumatic berlin</td>
</tr>
<tr>
<td>12</td>
<td>Area Valve Service System &amp; Line Isolation Valve</td>
<td>Atlas Copco / Amico / Ohio Medical / pneumatic berlin</td>
</tr>
<tr>
<td>13</td>
<td>Alarm Systems (Master &amp; Area)</td>
<td>Atlas Copco / Amico / Ohio Medical / pneumatic berlin</td>
</tr>
<tr>
<td>14</td>
<td>Bed Head Panels (Vertical &amp; Horizontal)</td>
<td>MPS / PES / Prenit / MDD / Active / Eubiq / Medirail Systems</td>
</tr>
<tr>
<td>15</td>
<td>High pressure tubes for O2, N2O, CO2, AGSS, Compressed Air &amp; Vacuum, Etc.</td>
<td>Atlas Copco / Amico / Ohio Medical / pneumatic berlin /Aktive</td>
</tr>
<tr>
<td>16</td>
<td>Gas Cylinders</td>
<td>Everest Kanto / Rama Cylinders / BPCL (BIS Approved Only)</td>
</tr>
</tbody>
</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.
CHAPTER- U

Technical Specifications- Modular Operation Theatres (MOTs)

SCOPE: Wall Paneling System
The prefabricated Operating Room should be Cladding structure insulated Stainless steel wall panels.
Total Panel thickness 50-60mm.

The SS Sheet of minimum 0.8mm thick made up of 304 Grade Stainless Steel. Sandwich panel (Both side 0.8mm SS 304 Sheet) with core consisting of rigid polyurethane foam, which has been injected under high pressure, with a minimum density of 40 kg/m3.

The individual wall panels shall use the tongue and groove technology for joining two panels, no welding should be allowed. The tongue & groove should be of steel and easy to operate.

The gaps between panels shall be suitably filled with metal filler/epoxy and sanded flush.

Stainless Steel plate finished to fine grain surface, treated properly to take antifungal paint.

Paneling should be easy to maintain, durable, antistatic/conductive and fire retardant.

Clearance between inner panel and outer wall should be sufficient to allow the maintenance personnel for service. This closed space should be flushed continuously to eliminate dust and bacterial accumulation.

Anti-bacterial paint should be coated on the wall.

Bidder should maintain anti-bacterial paint during warranty and CMC period.

Wall elements should be resistant to all standard cleaning agents, disinfectants and fumigation agents.

Panel should be covered with protective sheath to prevent scratch during installation.

It should have minimum number of junction. The junction should be seamless and should be sealed with suitable sealants.

The wall panels should be CE/UL Listed/BIS/DIN 1.4301 certified

Third party test certificate for SS304 from material testing lab (Govt. Authorized) - to be provided at the time of pre dispatch inspection/supply.

SCOPE: Ceiling Paneling System
The prefabricated ceiling plates /cassettes should be made up of SS 304 panels with sheet thickness of at least 0.6 mm. Sandwich panel (Both side 0.6mm SS 304 Sheet) of PUF with minimum density 40kg/m3 with matt finish and should be coated with antibacterial paint. It should be from the same manufacturer of wall panel. Total thickness should be 30-40mm.

Support elements: high quality Suspension bracket with tension spring.
Material: High quality galvanized or powder coated steel.

Room lighting, air supply inlet, ceiling service units, return air outlets, etc should be integrated with SS metal ceiling system.

The individual panels except those at the edges should be removable individually.

The ceiling material should be CE/ UL/BIS/DIN 1.4301 certified

Anti-bacterial paint should be coated on the ceiling.

Third party test certificate for SS 304 from material testing lab. (Govt. authorized) - to be provided at the time of pre dispatch inspection/supply.

SCOPE: Laminar Air Flow System
The ceiling filtration system should be designed to ensure unidirectional distribution of sterile air of the surgical theatre to ensure the cleanliness of all the area covered by the air flow.

The Laminar flow system should comprise of thick extruded aluminum profiles frame and sealed gasket. The filters installed in the plenum should be suitable for application for laminar flow and clean rooms. These filters should meet following specification.

Separators : continuous thermo plastic chord
Sealant   : Polyurethane
Gasket    : One piece polyurethane
MPPS average efficiency: > 99.95%
3 Micron DOP efficiency > 99.99%
Final Pressure drop : 600 pa(max)
Maximum Operating Temp : 60 degree Celsius
Maximum RH  : 40-50%

The ceiling system should be equipped with “H 14” class HEPA filters position in the ceiling to achieve 0.25m/sec flow at the diffuser.

Filtration Ceiling System holding structure, Filter frames and top plenum should be made of
<table>
<thead>
<tr>
<th><strong>Aluminum/Stainless Steel.</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The filtration ceiling system should have diffuser/flow equalizer to achieve uniform &amp; constant air distribution over the whole surface. It should be CE/UL certified.</td>
<td></td>
</tr>
<tr>
<td>The air management system should be designed to achieve class 100 with the following parameters:</td>
<td></td>
</tr>
<tr>
<td>Bacteriological class = B (5 CFU/m³)</td>
<td></td>
</tr>
<tr>
<td>Particle decontamination kinetics CP = 5 min</td>
<td></td>
</tr>
<tr>
<td>ISO 14644/1 classification = ISO 5</td>
<td></td>
</tr>
<tr>
<td>Third party validation by Govt. approved environment lab (After installation)</td>
<td></td>
</tr>
<tr>
<td>The positive pressure should be maintained inside the OT to prevent contamination due to air from outside the OT.</td>
<td></td>
</tr>
<tr>
<td>The supplier should provide test certificate for HEPA filter and laminar air flow systems from the original manufacturers.</td>
<td></td>
</tr>
<tr>
<td>Size of laminar airflow system minimum 8 feet X 8 feet or more.</td>
<td></td>
</tr>
<tr>
<td>Should be CE certified.</td>
<td></td>
</tr>
<tr>
<td>Note: Prospective bidders are advised to collect the information regarding CFM and AHU capacity from the respective institute site. Total flow rate of filter bank shall match the CFM of AHU.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>HVAC Ducting &amp; Exhaust System</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>All the ducting inside the MOT shall be scope of the MOT bidder.</td>
<td></td>
</tr>
<tr>
<td>All the ducting should be as per industry standard and sheet should be Aluminum of appropriate thickness and insulated as per industry standard.</td>
<td></td>
</tr>
<tr>
<td>All necessary HVAC interconnection for supply and return air shall be the scope of bidder (the institute will provide the duct upto outside of each MOT)</td>
<td></td>
</tr>
<tr>
<td>Return air exhaust grill should be provided in the OT.</td>
<td></td>
</tr>
<tr>
<td>The exhaust air cabinets should be openable and cleanable.</td>
<td></td>
</tr>
<tr>
<td>These cabinets should have suction from bottom and top also.</td>
<td></td>
</tr>
<tr>
<td>Designed flow rate should not be less than 1000 m³/hr. Distribution of exhaust air volume should be divided between fluff strainers to maintain the required pressure within the theatre without causing turbulence.</td>
<td></td>
</tr>
<tr>
<td>The Exhaust air cabinet should be manufactured and supplied by the supplier of wall and ceiling system supplies.</td>
<td></td>
</tr>
<tr>
<td>Return air exhaust cabinet should be made from SS304 and should be from the same manufacturer of wall panel. Also it should match perfectly with the ceiling system aesthetically</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>SCOPE: PVC Flooring</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>It should be with 2mm antistatic seamless PVC flooring</td>
<td></td>
</tr>
<tr>
<td>Floor should be smooth, non-slip, impervious material conductive enough to dissipate static electricity but not conductive enough to endanger personnel from electric shock.</td>
<td></td>
</tr>
<tr>
<td>Electrostatic charge dissipation combat PVC seamless flooring of very high quality should be provided.</td>
<td></td>
</tr>
<tr>
<td>Thickness not less than 2 mm. Continuous roll should be used and joints should be welded by special PVC thermal welding units using PVC welding bars of same colour</td>
<td></td>
</tr>
<tr>
<td>The sheets should be highly durable with resistance to shock and indentation. It should be scratchproof also. The conductive material should be uniformly impregnated as grains.</td>
<td></td>
</tr>
<tr>
<td>It should be inert to body fluids, chemicals and disinfectants. Should not be affected by temperature variation within the OT.</td>
<td></td>
</tr>
<tr>
<td>The floor should efficiently discharge electric charges up to 2 kV</td>
<td></td>
</tr>
<tr>
<td>Flooring should be done by skilled workers of accredited agencies authorized by the supplier of PVC sheets. The electrical resistance (point to ground) should be within $2.5 \times 10^4$ to $5 \times 10^6$ ohms. The floor should not allow buildup of electrical charge beyond 100 volts due to antistatic effect. The corners should not be terminated sharply and concealed cove- former (aluminum) should be used to overlap the wall panel to a height of approx. 25mm and sealed perfectly and uniformly. Self-leveling compounds should be used.</td>
<td></td>
</tr>
<tr>
<td>The conductive copper grid laid underneath the PVC sheet should be supported by liquid epoxy compounds allowed to set as a uniform and level surface. The copper strips to be made visible by grinding and no copper strip should project more than 0.5mm above level surface to avoid damage to the PVC sheet. One earthing lead should be brought out from every 150sq.ft area and attaching it to the main earthing strip/ground.</td>
<td></td>
</tr>
<tr>
<td>Copper grounding strips (0.05 mm thick, 50 mm width) should be laid flat on the floor in the conductive adhesive and connected to copper strip of grounding. The connection from copper grid should be brought out uniformly at places to form equipotential grid.</td>
<td></td>
</tr>
</tbody>
</table>
Flooring should be mechanically shock proof, scratch proof, flame retardant and anti-microbial.

Corners should be uniformly curved.

Final surface should be non-corrosive to biological fluids and detergents.

Colour should be uniform pleasant and matching with ambience and as approved by respective consignee.

Suitable self-leveling should be done before PVC flooring to avoid undulation within the MOT.

**SCOPE: Hermetically Sealed Doors & Windows**

<table>
<thead>
<tr>
<th>Door Sizes</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>HERMETICALLY SEALED DOORS</td>
<td>2.1mx1.8m</td>
</tr>
<tr>
<td>HERMETICALLY SEALED DOORS</td>
<td>2.1mx1.0m</td>
</tr>
<tr>
<td>HERMETICALLY SEALED DOORS</td>
<td>2.1mx1.8m with Lead Line(As per AERB Norms)</td>
</tr>
<tr>
<td>HERMETICALLY SEALED DOORS</td>
<td>2.1mx1.0 m with Lead Line(As per AERB Norms)</td>
</tr>
</tbody>
</table>

This should be a hermetically sealed, single sliding door of 2.1 (H) X 1.8 m(W)

The controller should be capable of being operated by elbow switches/foot switches as well as touch less sensor.

The track should be of stainless steel/Aluminum and the running surface for the top rollers should be suitably angled to reduce resistance to movement.

The door leaf should be hung by means of hard plastic rollers of high quality with double bearing at the top. Rollers should be provided under the stainless steel/Aluminum track to enable smooth and noiseless movement.

Opening and closing of the door should be microprocessor controlled electromechanical movement.

The door material should be of HPL Color should match the interior and care should be taken to make the leaf strong and light weight.

One should be able to open and close the door effortlessly in case of failure of automatic mechanism.

Door opening handle should be strong and sturdy. Material should be of SS (gloss finish). Should be provided with high quality cylindrical lock.

Door leaf should have high quality synthetic rubber gasket with long life to ensure hermetic sealing (to maintain air pressure differential). Air tightness 99.99% at a pressure of 100Pa.

The finished floor on either side of the door should be perfectly level (maximum permissible difference +1mm).

The overall thickness of the finished door should be **40-60mm**. The inner part of the door should be filled with CFC free polyurethane foam thickness of 48mm or nearby. (Sealed airtight to prevent further ingress of any microbial organism).

The door and controls should comply with IEE regulation. All motors used should be DC brushless motors with essential isolation from mains.

Door should be with vision window 300 mm x 300 mm with double glazed panels and hermetically sealed.

Door movement should have minimum noise.

The starting time after receiving the signal should be adjustable between 0.5 to 20 seconds.

The door controller should be CE marked.

Test certificate for hermetically sealed door frame (factory test certificate) should be enclosed with the pre dispatch documents.

**Hermetically Sealed Window with Motorized Blinds for MOT as per requirement. The approx. 1.5m x 1m or 1.5 x 1.5 m**

**SCOPE: Touch Screen Control Panel**

The touch screen panel should be touch screen panel. This control panel should work as the central control panel for the HVAC controls, instruction board. Touch screen, OT light control. The controller should be capable of adjusting the temp adjustment of +/- 5 Deg with in 5Minutes. It should be CE or UL Listed.

The touch screen should be wall mounted, stationed in the visibility line of the surgeon and OT staff. The access height should be convenient for the nurse to operate and help/assistant when in need.

The panel should accommodate digital clock and the elapsed time indicator.

The medical gas alarm should indicate high and low gas pressures for each gas service present in the OT including vacuum. This should be supported by audible alarm also. The panel should have an alarm mute (fault annunciation) facility. The sensors (pressure switches) should be at the nearest isolation valve.

Control for general lighting: ON/OFF and dimming controls organized in groups to provide uniform...
Illumination.

Control of the operating light (major and satellite and camera control (on/off and intensity control) should be provided.

Hand free telephone set with memory should be located at one side.

Temperature and humidity control for the room connected to the AHU. (Adjustable from the panel) The controller should be capable of adjusting the temp adjustment of +/- 5 Deg with in 5 Minutes wherever separate AHU is provided for each OT.

Digital room pressure indicator in cm of H2O or equivalent (signal from pressure sensor shall be provided to indicate pressure differential between OT and outside)

HEPA filter bank differential pressure indicator.

The control Panel should be able to integrated with HIS/BMS

The Control Panel should able to display the Isolation Panel Alarm Conditions along with MGPS Alarms

The touch screen size should be minimum 32 inch color LED

<table>
<thead>
<tr>
<th>SCOPE: Pressure Relief Dampers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure relief dampers or over flow ports should be provided in each room to prevent contamination of air from clean and dirty areas.</td>
</tr>
</tbody>
</table>

Suitably sized air pressure relief damper should be strategically placed, enabling differential room pressure to be maintained and ensure that when doors are opened between clean and dirty areas.

Counter- weight balancing system should be provided in the PRD to maintain positive pressure inside the operation room.

Air pressure stabilizers should have unique capability of controlling differential pressure to close tolerance. The PRD should remain closed at pressure below the set pressure and should open fully at a pressure only fractionally above the threshold pressure.

The frame, body and blade should be of grade SS304 stainless steel.

<table>
<thead>
<tr>
<th>SCOPE: Hatch Box</th>
</tr>
</thead>
<tbody>
<tr>
<td>It should be provided in each operation theater to remove waste materials from the operation theater to dirty linen area/corridor just adjacent to Operation Theater.</td>
</tr>
</tbody>
</table>

Each hatch box should be equipped with two doors and the door should be operated electrically/motorized.

The hatch should be designed in such a way that only one door should be opened at one time.

The UV light should be so installed that it is kept on while both the doors are closed. This UV light has to be automatically turned off in case of opening of either of the doors.

Indicators should be provided on both sides of the OT so that door open / close status can be monitored from both sides.

Hatch Box material should be SS304 grade.

Size of the Hatch box minimum: 600mm x 600mm.

<table>
<thead>
<tr>
<th>SCOPE: Operating List Board</th>
</tr>
</thead>
<tbody>
<tr>
<td>One operating list board should be provided in each operating theater.</td>
</tr>
</tbody>
</table>

It should be made of ceramic having magnetic properties and should be flushed to the wall of the operating room.

<table>
<thead>
<tr>
<th>SCOPE: X-ray Film Viewer</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED type flat panel X-ray viewing panel should be supplied.</td>
</tr>
</tbody>
</table>

This should comply with relevant electrical safely codes.

Mounting should be flush with the wall to avoid dust accumulation and growth or organisms between wall and panel.

Body should be of extruded aluminum powder coated black with bacteria resistant and disinfectant resistant finish.

The diffuser on the front panel should be a uniformly lit screen.

Dimming electronic control should be enclosed at the bottom of the cabinet.

Proper spring loaded film clip with rollers should be provided to hold the films firmly and to remove the film without scratches.

This should be 2 Numbers of dual panel viewing screen (14"x17" each), it may be on one wall panel or adjacent.

<table>
<thead>
<tr>
<th>SCOPE: Scrub Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compact surgical scrub sink should be designed for use in OT complex providing for pre procedural scrub up.( Double sink combination(2bay type) as suitable)</td>
</tr>
</tbody>
</table>

Each fixture should be fabricated from heavy gauge type 304 stainless steel (minimum thickness
1.5mm) and should be seamless welded construction, polished to a satin finish.

The scrub sink should be provided with a front access panel which should be easily removed for access to the water controlled valve, waste connections, stoppers and strainers.

Hands free operation should include infra-red sensors with programmable adjustment.

Thermostatic mixing, valve control should be located behind the access panel and maintain constant water temperature.

Timing should be adjustable to meet individual application requirements.

Provided with infrared sensors, thermostatic control taps with fail safe temperature controls.

All units should have reduced anti-splash fronts.

Knee/foot operated switch should be provided additionally.

**SCOPE: Storage Units**

The storage unit should be made with 1 mm thick stainless steel panels.

The shelves should be of SS 304 & removable for cleaning.

The storage unit should be divided 2 or more parts and each part should have individual glass doors/or common glass door with high quality locking system.

The overall size should be minimum 200 cm X 120 cm X 40 cm.

**SCOPE: OT Pendants (Anesthetist & Surgeon)**

**Double arm moveable Pendant for Anesthetist**

The Pendants should comply with NFPA 99C/HTM 02-01/DIN. The support arms should be extremely robust and revolve on high quality bearings, so that the pendant head glides smoothly and quickly to any desired position.

Double moveable arms (any combination) with total coverage of min 1800mm and 330 deg. Horizontal movements for each arm. Vertical movement should be motorized and the arm height should remain to a height greater than 6.5 feet above floor level.

Weight carrying capacity of the arm should not be less than 180 Kg. should have electromagnetic/pneumatic brakes.

Each arm should be capable of 300-340 degrees of rotation, which can be easily adjusted to suit the desired mode of operation.

The pendant should be European CE Certified with 4digit notified body number or US FDA approved.

The **Pendant Service Heads should be modular with minimum 1000mm head. The heads should be capable of accepting a range of shelves, infusion poles, electrical switch/sockets, gas outlets other accessories as asked in tender. The Pendant Heads should support the range of Physiological Monitor Mounting Solutions.**

The Pendant Service Heads should be supplied with medical gas terminal units and 5/15 or 6/16 Amps hybrid Sockets with switches.

Double arm pendant anesthesiologist and surgeon : Each pendant should be supplied with minimum outlets and probes as mentioned below –

- Oxygen Outlets – 2 nos.,
- Vacuum Outlets – 2 nos.,
- Nitrous oxide – 2 nos.,
- Air(4 bar) Outlets - 2 nos.,
- AGSS outlet - 1 no
- Electrical sockets - 10 nos.
- Adjustable Shelf with two rails one on each side – 3 no.
- IV Fluid Pole with 4 hooks – 1 No.
- Data socket RJ-45 -2 nos.
- Pendant supplier should provide cutouts for Patch Panels in Integrated OTs. (only for integrated OT)

**Double arm moveable Pendant for Surgeon**

The Pendants should comply with NFPA 99C/HTM 02-01. The support arms should be extremely robust and revolve on high quality bearings, so that the pendant head glides smoothly and quickly to any desired position.

Double moveable arms (any combination) with total coverage of min 1800mm and 330 deg. Horizontal movements for each arm. Vertical movement should be motorized and the arm height should remain to a height greater than 6.5 feet above floor level.

Weight carrying capacity of the arm should not be less than 180 Kg. should have electromagnetic/pneumatic brakes.
Each arm should be capable of 300 - 340 degrees of rotation, which can be easily adjusted to suit the desired mode of operation.

The pendant should be European CE Certified with 4 digit notified body number or US FDA under Medical Devices Directive.

The Pendant Service Heads should be modular with minimum 1000mm head. The heads should be capable of accepting a range of shelves, infusion poles, electrical switch/sockets, gas outlets other accessories as asked in tender. The Pendant Heads should support the range of Physiological Monitor Mounting Solutions.

The Pendant Service Heads should be supplied with medical gas terminal units and 5/15 or 6/16 Amps hybrid Sockets with switches.

Each pendant should have – Each pendant should be supplied with outlets and probes as mentioned below –

- Oxygen Outlets – 1 nos.,
- Vacuum Outlets – 2 nos,
- Air (7bar) Outlet- 01 nos,
- CO2 Outlet - 01 nos.,
- Nitrous oxide – 1 nos.,
- Air (4 bar) Outlets - 1 nos.,
- Electrical sockets - 10 nos.
- Adjustable Shelf with two rails one on each side – 3 no.
- Data socket RJ-45 -2 no.
- IV Fluid Pole with 2 hooks – 1 No. (Pole should be capable of stacking 4 nos of syringe pumps)

Pendant supplier should provide cutouts for Patch Panels in Integrated OTs (only for integrated OTs).

**SCOPE: Peripheral lighting & Clean room luminaries**

To provide peripheral lighting and clean room luminaries with intensity min 500 Lux, it should be minimum 8 in numbers for each OT. Should be with highly specular anodized aluminum reflectors and optical antiglare system.

Luminaries cover should be made of highly resistant, disinfectant proof laminated safety glass/acrylic with stylish fine grained surface.

The reflectors should be of high quality, cleanable and non-deteriorating.

The white luminaries body should be made of sheet steel/ perfectly powder coated, supplied ready for connection optionally for individual or series circuit with digital electronic control gear in multiamp technology.

Recess frames should be gas tight. The fitting should be flush with the ceiling and should be removable from top or bottom. The light fitting should be uniformly and aesthetically distributed on the ceiling to provide uniform illumination in the OT. Light should not interfere when green mode endoscopy is performed

Peripheral lighting should be done according to IP65 (international protection rating 65) / IP 54 regulations.

Control equipment for the general lighting and the light dimming should be provided in the theatre control panel.

**SCOPE: Electrical Installation**

Power distribution within the OT should be provided from distribution boards located local to each theatre. Sub mains power to these panels should be by the general electrical contractor. From these panels all distribution services within the departments should be run. Isolated power supply, insulation measuring and protection as per IEC standards should be provided. This unit should be EN/CE/UL/FDA/IEC certified.

Earthed equipment bonding of all exposed metalwork should be provided.

Power sockets within the Operating Theatres ancillary areas should be matched to the rest of the hospital.

Each wall of MOT should have minimum 02 Nos. 6/16A hybrid switch socket & 32A industrial socket (For C Arm/Microscopes/Etc) at any two walls as per IEC standard.

Light fittings within the clinical areas should be recessed LED type with control gear

Fittings should be sealed in accordance with the standard IP54.

All equipment should be fully and permanently labeled to identify and describe the function, operation and voltage of the apparatus concerned. Throughout and upon completion of the electrical installation, tests in accordance with relevant sections of the local wiring regulations should be carried out and the results recorded.

All the conducting should be of MS/SS only as per IEC standard and suitable for hospital use only.
### SCOPE: Distribution Box (UPS Power and RAW Power)

All high voltage equipment should be installed in a separate enclosure.

The remote cabinet should house the operating lamp transformers, mains failure relays, UPS, electrical distribution equipment & circuit protection equipment for all circuits within the operating theatre.

All internal wiring should terminate in connectors with screw & clamp spring.

Connections of the clip- on type mounted, on a CE approved rail & labeled with indelible proprietary labels.

Individual fuses or miniature circuit breakers should protect all internal circuits.

Complete schematic drawing with description should be enclosed with the equipment.

DB Should have minimum two 32A/16A(As per requirement) extra circuits with MCCB/MCB for future uses like integration equipment, etc.

All MCBs & MCCBs present in DBs should be permanently labeled to identify and describe the function, operation of concerned equipment/function.

### SCOPE: Isolation Panel System (IPS)

Isolation Panel System of minimum 10/20 KVA capacity (As per power requirement of MOT - in case of 10KVA, bidder shall provide 2 nos. for each MOT to meet the power requirement) should be provided for every operation theatre which ensures the safety of staff and patient. System should have isolators provided through leakage relays etc. (If required) according to IEC recommendation. This unit should be EN/CE/UL/BIS/FDA/IEC certified. These systems are to be commissioned by specialists.

Should be medical grade Insolation panel

Should have fault detection feature

Should be compliant to CEI 64-8 / IEC 60364-7-710/BS7671 Standard

Should be mountable on wall & compact

The IPS should be able to integrate with HIS/BMS and Surgeon Control Panel as standard

### SCOPE: Online UPS

Backup should be minimum 30min.

The room for the central UPS will be provided by the respective institute/hospital preferably at same OT floor and one point electric supply will be provided to the UPS Room by the respective institute/hospital.

Bidder should provide required electrical wiring from UPS to all modular MOT as per IEC/International standard.

Electrical control panel complete with MCCB, Switchgears etc should be provided.

Per MOT UPS load should be provided minimum 20 KVA with one 20 KVA backup for all OTs and redundancy( n+1) should switch automatically. The battery bank may be common for UPS (eg. For 15 OT, 15x20 =300KVA +20KVA backup and for 2 OT, 2x20KVA +20KVA backup)

### SCOPE: Medical Gas Lines Installations

The bidder should ensure that all works carried out are to the recommendation made in the Department of Health and Social Securities HTM 02-01 /NFPA 99C / DIN

Bidder should provide Oxygen, Air(4Bar & 7bar), Vacuum, AGSS, CO2 and Nitrous Oxide supply to Operation Theatres from the existing lines terminated outside the OT.

Bidder shall be responsible for supply, installation, testing and commissioning of complete MGPS system inside the operation theatre including Distribution piping, Pendants, outlets and other essential accessories.

Terminal units should be gas specific and only accept the correct Medical gas probe. Gas specific components shall be pin indexed to ensure that a correct gas specific assembly is accepted.

Each terminal unit should be identified by the appropriate recognized name or symbol, colour, coding and shape as per HTM 02-01 /NFPA 99C. Outlets should be CE certified/UL listed.

Copper pipes should be of solid drawn, seamless, deoxidized, non-arsenical, half hard, tempered and degreased copper pipe. All copper pipes should be degreased & delivered capped at both ends. The pipes should be accompanied with manufacturers test certificate for the physical properties & chemical composition. The copper pipe should comply with EN 13348

Copper pipe must have reputed third party inspection certificate (Eg. Lloyd’s, TUV, SGS).

Fittings should be made of copper and suitable for a working Pressure of up to 17bar and especially made for brazed socket type connections

The copper fitting should comply with EN 1254-1

The Brazing filler material should comply with EN 1044

### SCOPE: Site Modifications
Any demolition, reconstruction, water proofing, necessary plumbing, anti-microbial painting, replacement/shifting of any door or windows to provide structured design within the OT area for modular OT should be carried out by the bidder for successful installation and commissioning of MOT.

**SCOPE: OT Light with camera, Monitor & Recorder**

**OT Light – LED**

Operating Room Surgical Lighting System should provide an ideal combination of brightness, maneuverability, and shadow resolution without sacrificing color accuracy through a consistent LED technology.

Such Lighting System should have the following technical specifications:

- **Number of Light heads**: Two per suspension
- **Color Temperature range**: 3800k-5000k (±10 %)- Variable color temperature.
- **Field Size Diameter**: 20 to 28cm (+/- 10%)
- **Working Range**: 750 to 1100mm (+/- 10%)
- **Illumination Level**: 160000Lux (Major Dome & Minor dome)
- **Rotation**: 360-330degrees
- **Sterilizable Handle**: 02Nos.
- **Mounting Type**: Ceiling
- **Supply Voltage**: 230 VAC 50 Hz
- **Bulb Type**: LED
- **Dimming Range**: 50% - 100%
- **Operating/Storage Humidity**: 10 – 95%
- **Life of Light Source**: >40,000 Hrs

Should be provision to mount the camera in one dome.

Surgical Light System Should be European CE with 4digit notified body/US FDA certified or Declaration of Conformity for quoted model with ISO 13485 issued by 4digit notified body.

**HD Camera System – 1080p/i.**

Description: Integrated In-Light Camera System should be integrated at the center of one of the domes of this lighting system/ third arm in order to capture images & video sequences of the open cases.

Such a autofocus – Lockable camera should have the following specifications -

- **Signal to Noise Ratio (S/N Ratio)**: >50 dB
- **CCD/CMOS**: 1/3" or 1/2.8"
- **Optical Zoom**: 10X
- **Digital Zoom**: 12-15X
- **Video Output**: HD, DVI, S-Video & Composite Video
- **White Balance & Gain**: Automatic/Manual

Light and Integrated Camera should have a control through Touch Panel of the control equipment placed inside the operating room.

**HD LED FLAT PANEL MONITOR (Only for non integrated OT's)**

Should be 30-32" High Definition Progressive Scan Flat-panel Monitors with ceiling mounted spring arm suspension to support high definition/HDTV progressive Scan images and should be able to support and display DVI/HDTV, RGBHV, S-Video, Composite video signals. Aspect ratio 16:9/16:10. Resolution – 1920X1080 or better.

The flat Panel suspension should be ready with the cables for integration of High Definition Digital (DVI/HDTV), RGBHV (High Resolution), SVHS (S-Video), Composite video signals to travel from the various sources of video like endoscopic camera, room camera, in light camera, high definition flat panel monitors, while assuring native resolution / signal.

Monitor should capable of displaying from other sources like endoscope, microscope, etc. necessary provision should be provided as standard.

**Recording system to be offered separately (Only for non integrated OT's)**

Recording system to be offered separately. Recording system should be full HD medical grade monitor LCD 19” touch screen and having the one TB storage space.

Data cable for communication from both pendants and monitors should be laid down up-to outside of OT in a patch port for future expansion for all OT’s where there is no integration

Patch Panel for power & signal to be laid down for 32” LCD Monitor at wall of MOT

Recorder should be capable of recording video from other sources like - microscopes, endoscopes. Etc., suitable provision should be provided as standard.
<table>
<thead>
<tr>
<th><strong>SCOPE: MOT Integrations for 6 OTs</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INTEGRATION AND DATA MANAGEMENT SYSTEM FOR 6 MODULAR OT</strong></td>
</tr>
<tr>
<td><strong>Display Medical Grade Monitor for integrated MOTs (One for each Integrated MOT)</strong>-</td>
</tr>
<tr>
<td>Screen size should be 26” or more.</td>
</tr>
<tr>
<td>Monitors should be high-definition (1920X1080p) medical grade monitor flat panel LED/LCD with LED backlights color screen</td>
</tr>
<tr>
<td>The monitors should be mounted on a boom arm/Pendent/3rd arm of OT Light as suggested by consignee/HITES the mounting accessories (if any) should be provided by bidder</td>
</tr>
<tr>
<td>Patch panel for power &amp; signal to be laid down for LCD Monitors present at Wall/Pendent/boom arm/OT Light arm by bidder.</td>
</tr>
<tr>
<td><strong>3D Medical Grade Monitor (One for each Integrated MOT)</strong></td>
</tr>
<tr>
<td>26” or more Full High Definition (1920X1080p) medical grade monitor, flat panel LED Colour screen to display both 2D &amp; 3D images.</td>
</tr>
<tr>
<td>Ceiling Boom Arm for 3D monitor – boom arm should be capable of holding 26inch/32inch monitors and all fixation related work for the same should be responsibility of bidder</td>
</tr>
<tr>
<td><strong>Audio Video Communication System cum control system (One for each Integrated MOT)</strong></td>
</tr>
<tr>
<td>The Integrate MOT should be connected to any Integrated MOT of institute (with in same building without internet connection) and can connect any Conference room/Other MOT/Doctors lounge/Etc. for video conferencing and live transmissions through IP calling. All necessary hardware and software should be provided by bidder</td>
</tr>
<tr>
<td>The Audio/Video Router/Switch system should have the minimum 8 x 8 or minimum 15 (including input &amp; output) Digital with open architecture. The routing/Switch system should be able to integrate and route all audio and video signal for eg. SD, Full HD &amp; 3D signal (e.g. Room Camera/OT Light Camera/Endoscopy/Microscope/Etc) available inside OT.</td>
</tr>
<tr>
<td>Required numbers of Decoders and Encoder or Convertors or Scalers or Transduces should be supplied as per the respective institute requirement.</td>
</tr>
<tr>
<td>The Integration system should receive the signal from different sources like Room camera, Endoscopy camera, Overhead camera, Archiving System, Auxiliary devices like C-Arm, Video Microscope, Mobile ultrasound, microphones, AUX-IN &amp; video conferencing, etc and able to integrate all signal and give flexibility to route the signals/videos at desire destination/monitors.</td>
</tr>
<tr>
<td>The routing system should allow selection of multiple views for simultaneous transmission in QUAD or PIP format.</td>
</tr>
<tr>
<td>PACS dedicated PC has with trolley to be provided in each OT or integration system should able to receive and transmit the PACS Data from source.</td>
</tr>
<tr>
<td>Patient and image data should be able to call up and distributed to required monitors in the operating room</td>
</tr>
<tr>
<td>All the patch panel work required for Hardware of OT Integration system should be in the bidder’s scope of work and also necessary co-ordination with consignee/HITES, MOT Vendor, construction vendor and HLL/HITES will be the responsibility of the bidder for successful completion of the all associated works.</td>
</tr>
<tr>
<td>Video Conferencing system should be offered and the system should be able to transfer high quality real time images and audio signals from multipoint at a minimum speed of 2Mbps. The system should be compatible to 1080p full HD resolution for transmission over the ISDN lines or IP Service.</td>
</tr>
<tr>
<td>The conferencing system should be controlled via the touch screen of the integration system from the OT. Suitable Number / Sets of Transmitters, Receivers and Cables, connectors and accessories should be offered as per the requirement.</td>
</tr>
<tr>
<td>Two numbers HD camera with 10x or more optical zoom should be provided in each Integrated MOT as standard( One dedicated for VC &amp; other for room view)</td>
</tr>
<tr>
<td>Hardware for two way conferencing should be provided in each Integrated MOTs like wireless mic, speakers, aux in and aux out &amp; in for connecting extra mic, USB/HDMI/etc input on OT wall panel in patch.</td>
</tr>
<tr>
<td>Cabling for 2way conferencing between integrated MOT to integrated MOT within the hospital building will be responsibility of bidder.</td>
</tr>
<tr>
<td><strong>Digital Documentation System (One for each Integrated MOT)</strong></td>
</tr>
<tr>
<td>Medical grade recorder should be provided along with monitor to display the recording/control.</td>
</tr>
<tr>
<td>Should have provision to record FHD &amp; 3D images and video sequences from integrated MOT.</td>
</tr>
</tbody>
</table>
| The Full High-Definition Digital Documentation System should be a high-end computer system designed specifically for recording, managing, and archiving surgical images and video in native full HD & 3D
resolution. The captured full high-definition images & videos can be accessed from the hard drive for printing or saving onto multiple forms of external media which includes CD/DVD, USB Flash Drive & Hospital network. It should be able to preview and simultaneously record views from two video sources parallel and archive as single patient file.

Integration of equipment/Signals/Sources with the Central Control System in such a way that the central control system is capable to route any running high-definition surgical videos, which is being recorded in it, onto any display device in an operating room.

It should have at least 320GB internal Hard Disk Drive (HDD) & 2TB External online storage for in-system archiving. Also, it should have a feature of real time in-procedure DVD burning besides at-the-end procedure DVD burning.

Patient and image data should be able to call up and distributed to required monitors in the operating room.

**Viewer Monitor**

One 40inch or more FHD monitor should be install on Integrated MOT wall with proper frame (flush mounted only) and integrated with Integration system. Any image can be routed to that monitor as per requirement. Location of this monitor will be finalized at the time of drawing approval.

<table>
<thead>
<tr>
<th>List of Approved Makes for MOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Wall Paneling System</td>
</tr>
<tr>
<td>2. Ceiling Paneling System</td>
</tr>
<tr>
<td>3. Laminar Air Flow System</td>
</tr>
<tr>
<td>4. Internal HVAC Ducting &amp; Exhaust System</td>
</tr>
<tr>
<td>5. PVC Flooring</td>
</tr>
<tr>
<td>6. Hermetically Sealed Doors</td>
</tr>
<tr>
<td>7. OT Pendants (Anesthetist &amp; Surgeon)</td>
</tr>
<tr>
<td>8. Peripheral lighting &amp; Clean room luminaries</td>
</tr>
<tr>
<td>9. Isolation Panel System (IPS)</td>
</tr>
<tr>
<td>10. Online UPS</td>
</tr>
<tr>
<td>11. Medical Gas Lines Installations</td>
</tr>
<tr>
<td>12. OT Light with camera, Monitor &amp; Recorder</td>
</tr>
<tr>
<td>13. MOT Integration for 6 Ots</td>
</tr>
</tbody>
</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.

END OF VOLUME – 5