

CONSTRUCTION OF SUPER SPECIALTY HOSPITAL FOR GOVT. RAJAJI HOSPITAL AT MADURAI.

**MINISTRY OF HEALTH & FAMILY WELFARE
GOVERNMENT OF INDIA, NEW DELHI
PRADHAN MANTRI SWASTHYA SURAKSHA YOJNA**

**TENDER DOCUMENT
FOR
*CONSTRUCTION OF SUPER SPECIALITY HOSPITAL
FOR
GOVT. RAJAJI MEDICAL COLLEGE, MADURAI***



**PART III
TECHNICAL SPECIFICATION**

**TENDER NO. HLL/ID/13/64
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INTRODUCTION

These Specifications and Conditions define the basis for the construction outputs that HLL Life care Limited requires the Contractor to provide in respect of the new CONSTRUCTION OF SUPER SPECIALTY HOSPITAL FOR GOVERNMENT RAJAJI HOSPITAL, MADURAI, TAMIL NADU.

The work in general shall be carried out in conformity with the CPWD specifications for works 2009 Vol. I and Vol. II, CPWD General Specifications for Electrical works Part –I Internal (2013), Part III Lifts & Escalators (2003), Part –IV Substation (2013), Part – V Wet riser & Sprinkler Systems (2006), Part VII DG Sets (2013) and Specifications for Heating, Ventilation & Air Conditioning (2004) along with correction slips issued up to the date of receipt of tender.

This volume provides only additional specifications and specifications for works for which no CPWD Specifications have been published

The following standards shall apply unless otherwise stated:

- The Relevant CPWD Specifications for Works
- The standards set out in National Building Code of India 2005
- The National Electrical Code, 2011
- The Indian Electricity Act 2003
- The Relevant BIS Standards
- The Bio Medical Waste (Management & Handling) Rules 1998
- Requirements of the local Water Supply Company, Electricity Supply Company/Department
- Requirements of the Pollution Control Board, Fire officer and Aviation authorities if applicable

Discrepancies in Specifications:

In the event of any discrepancies in technical specification with respect to the corresponding ones in CPWD general specifications, the work has to be executed as instructed by the Engineer in charge.

In the event of any silence of specifications the tenderer is obliged to execute the works in compliance with the best industrial/Construction practices subject to the tenderers proposals duly accepted by the Engineer in Charge.

TECHNICAL SPECIFICATIONS

TECHNICAL SPECIFICATIONS FOR CIVIL WORKS

EXCAVATION AND EARTH WORK

1.0.1 **General:** The excavation will generally refer to open excavation of wet or dry.

1.0.2 **Examine the Site :**

The contractor shall visit and ascertain the nature of the ground to be excavated and the work to be done and shall accept all responsibility for the cost of the work involved.

1.0.3 **Clearing the site :**

The site levels are shown in the drawing and the area required for setting out and other operations like roads, drains, shades etc., should be cleared and all obstructions, loose stones, materials and rubbish of all kinds, stumps, brush wood and trees removed as directed, roots being entirely grubbed up. The materials obtained will be the property of CLIENT, and materials considered useful by CLIENT, will be handed over to Employer and till such time the contractor shall be responsible for the custody of the material (The contractor to his own dump at his own cost will remove rejected materials).

1.0.4 **Ground Levels and Site Level Plan :**

Before starting the excavations, the requisite block levels of the entire plot shall be taken by the contractor in association with HLL Engineer-in-charge, and a proper record of these levels kept which the contractor and Engineer in charge, shall jointly sign.

1.0.5 **Setting out :**

After clearing the site and preparing the site level plan, the contractor will set out the center lines of the building or other involved works and get the same approved from HLL Engineer-in-charge. It shall be the responsibility of the contractor to install substantial reference marks, benchmark etc., and maintain them as long as required by HLL Engineer-in-charge. The contractor will assume full responsibility for proper setting out alignment, elevation and dimension of each and all parts of the work.

1.0.6 **Excavation and Preparation of the Foundation of Concreting :**

Excavation shall include removal of all materials of whatever nature all depths and whether wet or dry (including mass excavation) exactly in accordance with lines, levels, grades and curves shown on the drawings or as directed by the HLL Engineer-in-charge. The bottoms of excavation shall be leveled both longitudinally and transversely or stepped as directed by HLL Engineer-in-charge. Should the contractor excavate to a greater depth than shown on the

drawings or as directed by HLL Engineer-in-charge he shall at his own expense fill the extra depth by cement concrete mix 1:5:10 at his own cost as directed by HLL Engineer-in-charge.

The contractors shall report to HLL Engineer-in-charge, when the excavation is ready to receive concrete. No concrete shall be placed in foundations until the contractor has obtained HLL Engineer-in-charge, approval. In case, the excavation is done through different strata of soil and if the same is payable as per provision in the schedule of quantities the contractor shall get the dimensions at the strata payable decided from HLL Engineer-in-charge, if no specific provision is made in the schedule of quantities, it will be presumed that excavation shall be in all types of soil and the contractor's rate shall cover the same.

After the excavation is passed by HLL Engineer-in-charge, (and before laying the concrete) the contractor shall get the depth and dimensions of the excavation and levels (and nature of strata if applicable as per schedule of quantities like soil, hard rock, soft rock etc.) and measurements recorded from Engineers – in charge on site.

1.0.7 Shoring

If so directed the sides of the excavations should be timbered and shored in such a way as is necessary to secure them from failing in and the shoring shall be maintained in position as long as necessary. The contractor shall be responsible for the proper design of the shoring to hold the sides of the excavation in position and ensure safety from the slips and prevent damages to work and property and injury to persons. The shoring shall be removed as directed after the items for which it is required are completed.

1.0.8 Protection :

All areas where excavation is being carried out shall be fenced and in charge of watchman to avoid accidents. Adequate protective measures shall be taken to see that the excavation does not affect or damage adjoining structures. All measures required for the safety of the excavation, the people working in and near the foundation, trenches, property and the people in the vicinity shall be taken by the contractor at his own cost, he being entirely responsible / payable for any injury and damage to property caused by his negligence or accident due to his construction operation.

1.0.9 Stacking of excavated materials :

All materials excavated will remain the property of CLIENT and rate for excavation includes sorting out of useful materials and stacking then on site as directed. Materials suitable and useful for back filling, plinth filling or leveling of the plot or other use shall be stacked in convenient places but not in such a way to obstruct free movement of men, animals and vehicles or encroach on the NOC Building,

1.0.10 Backfilling :

All shoring, formwork shall be removed after their necessity ceases and trash of any sort shall be cleaned out from the excavation. All space between foundation masonry concrete and the sides of excavation shall be filled to the original surface with approved excavated materials in layers 15 cm to 20 cm in thickness, watered and rammed as per instructions of the Engineer-in-charge. The filling shall be done after concrete or masonry is fully set and done in such a way as not cause undue thrust on any part of the structure. Where suitable excavated materials are to be used for refilling, it shall be brought from the place where it was temporarily stacked and used in refilling.

No excavations of foundations shall be filled in or covered up until all measurements of excavation, masonry, concrete and other works below ground level are jointly recorded.

Black cotton soil shall not be used for back filling or in plinth filling.

1.0.11 Dewatering :

Rate for excavation shall include bailing or pumping out water which may accumulate in the excavation during the progress of work either from seepage, springs, rain or any other cause and diverting surface flow if any by bunds or other means. Pumping out water shall be done in such approved manner as to preclude the possibility of any damage to the foundation trenches, concrete or masonry or any adjacent structure. When water is met in excavation, pumping out water shall be from an auxiliary pit or adequate size dug slightly outside the excavation area. The depth of the auxiliary pit shall be more than the working foundation trench levels. The auxiliary pit shall be refilled with approved excavated materials after the dewatering is over.

The excavation shall be kept free from water (1) during inspection and measurement (2) when concrete and / or masonry are in progress and till they come above the natural water level, and (3) till CLIENT considers that the concrete / mortar is sufficiently set.

1.0.12 Rates to include :

Apart from other factors mentioned elsewhere in this tender; rates for the item of excavation shall also include for the following:

- (i) Setting out works as required and setting up benchmarks and other reference marks.
- (ii) Bailing and pumping out water, dewatering if any as required and directed.
- (iii) Excavation at all depths (unless otherwise specified in the schedule of quantities) and removal of all materials of whatever nature wet or dry and necessary for the contractor of foundation / basement etc.,
- (iv) Sorting out useful excavated materials and conveying beyond the structure and stacking them neatly on the site for backfilling or reuse as directed.

- (v) Necessary shoring and protection including labour materials and equipment to ensure safety and protection against risk or accident outside the premises of CLIENT, Building.
- (vi) Removal of surplus excavated materials as directed to contractors own dump.
- (vii) Drilling of small holes as directed to explore the nature of sub-stratum if necessary.

1.0.13 Measurement for excavation / filling :

Excavation shall be measured and paid as per the mode of measurements attached along-with this tender. Any additional excavation required for working space for work, planning, dewatering and strutting etc., shall not be measured and paid for separately but rates quoted for excavation shall include for all these factors. No increase in bulk after excavation shall be made.

1.0.14 Mechanical equipment's for the work :

Since the work is to be carried out on a mass scale the contractor may employ all mechanical equipment's for executing the work viz excavators, tippers and trucks etc.,

1.0.15 Mode of measurements :

The measurement of earthwork shall be done in cubic meters, unless otherwise mentioned. The measurements to be taken shall be those of the authorised dimensions from which soil has been taken out and shall be measured without allowance for increase in bulk.

1.1.0 EXCAVATION IN EARTHWORK INCLUDING ROCK CUTTING:

The measurement of excavation in earthwork including rock cutting shall be made as follows:

- a. Where the excavation is in trenches from borrow pits is fairly uniform ground, the measurements of cutting in trenches or borrow pits shall be made 'Dead me' or 'tell-tales' may be left at suitable intervals to determined the average depth of excavation
- b. Where the ground is not uniform levels shall be taken before the start, after site clearance and after the completion of the work and the quantity of excavation in cutting computed from themselves.
- c. Where soft / integrated rock and hard rock are mixed the measurement for the total quantity shall be made by method (a) or (b) given above. The hard rock excavated shall be stacked and measured in stack. The quantity of the hard rock excavated shall be arrived at as discussed in clause 1.1.12. From the total quantity of the mixture the quantity of hard rock excavated thus arrived at shall be deducted to work out the quantity of the soft, disintegrated rock excavated.

- d. Where hard/ dense solid, soft / disintegrated rock and hard rock are mixed, the measurement for the total quantity shall be made by the methods (a) and / or (b) given above. If possible after the removal of the hard / dense soil the levels of the exposed rock surface shall be taken and the quantity of the hard / dense solid removed, worked out from the difference between the original levels and the new levels. If this is not possible the excavation shall be completed leaving tell-tales and from the cross-section of these tell-tales, the area of the hard/ dense soil excavated at. Quantity of hard / dense soil shall then be deducted from the total quantities of excavation done. The balance shall then be treated as total quantity of hard rock and soft / disintegrated rock. The quantities of hard rock and soft/ disintegrated rock shall then be separated as in (c) above by stacking the hard rock separately.
- e. Where / Soft/Loose soil, hard/dense soil, soft/disintegrated rock and hard rock are mixed, the measurements of the entire quantity shall be made by methods (a) and or (b) given above. The separate quantities of soft / loose soil and hard / dense soil shall be worked out from the cross-section based on dead men or tell-tales as mentioned in (d) in case of hard dense soil. The total quantity of soft / loose and hard dense soil shall then be deducted from the total excavation to arrive at the total quantity of rock excavated. The rock quantities of soft / disintegrated rock and hard rock excavated are worked out separately as in case of (c) above.

Dressing or trimming side of excavations and leveling or grading and ramming of bottoms shall be described with the item of excavation except in the case of rough excavation.

All excavation shall be measured in successive stages of 1.5m stating the commencing level. This shall not apply to cases where no lift is involved as in hillside cutting.

All excavation shall generally be described as 'excavate and get out'. Getting out shall include throwing the excavated earth at least one meter or 1/3 depth of excavation whichever is more clear of the edge of excavation. The subsequent disposal of the surplus excavated material shall include with the item of excavation.

1.1.1 Filling

The actual measurement of the fill shall be calculated by taking levels of the original ground before start of the work after site clearance and after compaction of the fill at suitable intervals and the quantity of fill computed from these levels.

The deduction shall be made from actual measurements in all cases of fills except for floors as in 1.1.7 to arrive at net measurement of filling base on pre-accepted of specified deduction (state as percentage) for voids.

1.1.2 Surface dressing :

Trimming of natural ground excavated surface and filled up area to remove vegetation and /or small inequalities not exceeding 15 cm deep shall be described as surface dressing and measured in square meters.

1.1.3 Rough excavation :

Excavation exceeding 1.5 m in width as well as 10 sqm on plan but not exceeding 30cm in depth shall be described as 'surface excavation' and measured in square meters.

1.1.4 Surface excavation :

Excavation exceeding 1.5m in width as well as 10 sqm on plan but not exceeding 20 cm in depth shall be described as 'surface excavation' and measured in square meters.

1.1.5 Excavation Over area:

Excavation exceeding 1.5m in width as well as 10 sqm on plan and 30 cm in depth shall be described as excavation over areas and measured in cubic meters.

1.1.6 Return, fill and ram :

Returning , filling and ramming of excavated earth where not described with the item of excavation shall be measured in cubic meters and shall include spreading in layers not exceeding 20 cm in depth, watering, well ramming and leveling.

1.1.7 Filling under floors :

Filling under floors shall be measured in cubic meters and shall include spreading in layers not exceeding 20cm in depth watering well, ramming and leveling.

1.1.8 Lead and lift :

Lead: The distance for removal of excavated soil / rock shall be included in the respective items of work and shall not be measured separately. No extra lead will be paid under any circumstances.

All the items shall include loading and unloading.

Lift: All lift shall be included in the respective items of work and shall not be measured separately. No extra lift will be paid under any circumstances.

1.1.9 Planking and strutting

Planking and strutting if required to uphold the face of excavated earth etc., shall be included in the contractors scope of work and shall NOT be measured separately.

The description shall include use and waste of all necessary timber work, including wales, struts and open or close poling boards, their fixing and subsequent removal.

1.1.10 Site Clearance :

Before the earthwork is started, the area coming under cutting and filling shall be cleared of shrubs, rank vegetation, grass, brush wood, trees and saplings of girth up to 30 cms measured at a height of 1m above the ground level and rubbish removed up to a distance of 50m outside the periphery of the area under clearance. The roots of the trees and saplings shall be removed to a depth to 60 cms below ground level or 30cms below formation level or 15 cms below sub-grade level whichever is lower and holes or hollows filled up with earth rammed and leveled.

Cutting down trees of 30cm girth and over up to 100 cm girth shall be enumerated as an item. The cutting down of trees exceeding 100 cm girth shall be enumerated starting girth. The girth shall be measured at one meter above ground level. The item shall include lopping of branches and removal and disposal.

Digging out of roots including stacking shall not be measured separately but shall be included in the scope of work.

1.1.11 Classification

The materials to be excavated shall be classified as follows:

Soft / loose soil- generally any soil which requires the close application of pick and shovel, rake (or other ordinary digging implement) such as vegetable or organic soil, turf, gravel, sand, slit, loam, clay peat etc.,

Hard / Dense soil – Generally any soil which requires the close application of picks or jumpers or scarifiers.

Mud - A mixture of soil and water in fluid or weak solid state.

Soft / disintegrated rock (not requiring blasting) – Rock or boulders which may be quarried or split with crow bars. This will also include laterite and hard conglomerate.

Hard rock (requiring blasting) – Any rock or boulder for the excavation of which blasting is required as per Explosive Act and Rules.

Cutting in soft rock, if found, blasting operation in hard rock, chiseling in hard rock where blasting is prohibited shall be done only after written permission from CLIENT/ HLL Engineer-in-charge, and finalization of rates if the same is not existing in the BOQ.

1.1.12 Measurement

The length, breadth and height of the stacks shall be measured correct to a centimeter. The quantity shall be worked out in cubic meter correct to two places of decimal. The volume of stacks shall be reduced by percentages as shown against each for looseness in stacking to arrive at the net quantity for payment. The reduction shall be made in respect of the articles of materials for which mode of payment is by length or weight or numbers.

Earth:

- In loose stacks such as cartloads, lorry loads etc. – 20 %.
- In fills consolidated by light mechanical machinery – 10%.
- In fills consolidated by heavy mechanical machinery but not under OMC (Optimum Moisture Content) – 5%.
- In fills consolidated by heavy mechanical machinery at OMC (Optimum Moisture Content) – Nil.
- Consolidated fills in confined situation such as under floors etc., - nil.
- Stone metal, 40mm nominal size and above – 7.5%.
- Coarse aggregates / stone metal below 40mm nominal size – nil.
- Soiling stone – boulder 100 mm and above – 100%.
- Excavated rocks – 50%.

Any finds of archaeological interest such as relics of antiquity, coins, fossils or other articles of value shall be delivered to the Engineer-in-charge and shall be the property of the State Government.

1.2.0 EXCAVATION FOR FOUNDATIONS

1.2.1 Scope

This covers the excavation for simple types of foundation for buildings. Excavation for heavy foundations such as wide strip foundations, raft foundations and pile foundations are not covered in this specification.

1.2.2 Site Clearance :

Any obstacles, including the stumps of trees to a minimum of 60 cm below GL or 15 cm below foundation level whichever is lower, likely to interfere with the work, shall be removed. Holes left due to removal of old foundation, uprooted trees etc. Shall be stacked in such a place and manner as instructed by site engineer and the same shall remain the property of CLIENT unless otherwise specified.

1.2.3 Excavation:

Trenches for foundations shall be excavated to the exact width, length and depth as per dimensions on the drawing. The excavated material shall be used for refilling of trenches. The contractor at his own expense shall make provision for pumping and bailing out water. Excavated earth shall not be placed within 1M of the trench. Trenches shall be securely shored and timbered as per IS 3764, if the site engineer finds the same necessary. Excavation to dimensions greater than those shown in drawings shall not be paid for. In the event of excess depth the contractor shall fill up the excess depth by cement concrete mix 1:5:10 at his own cost, if so directed by the site Engineer.

1.2.4 Refilling :

The refilling of the excavation shall be done by consolidating in layer not exceeding 150mm thick with the minimum quantity of water necessary for

proper compaction. Surplus earth not required shall be removed and disposed as directed by the CLIENT / HLL Engineer-in-charge.

1.2.5 Measurement

- 1.2.5.1 The length and breadth of the excavation of filling shall be measured with a steel tape correct to the nearest centimeter. The depth of cutting or height of filling shall be measured, correct to 5mm by recording levels before the start of the work and after the completion of work. The cubical contents shall be worked out to the nearest two places of decimal in cum.
- 1.2.5.1 In case the ground is fairly uniform and where the site is not required to be leveled the engineer-in-charge may permit the measurement of depth of cutting or height of filling with steel tape correct to the nearest centimeter. In case of borrow pits, diagonal ridges, cross ridges or dead men, the position of which shall be fixed by the engineer-in-charge, shall be left by the contractor to permit accurate measurement being taken with steel tape on completion of the work. Deduction of such ridges and dead men shall be made from the measurements unless the same are required to be removed later on the earth so removed in utilized in the work. In the later case, nothing extra will be paid for their removal as subsequent operation.
- 1.2.5.2 Where ordinary rock and hard rock is mixed, the measurement of excavation shall be specified above. The two kinds of rocks shall be stacked separately and measured in stacks. The net quantity of the two kinds of rocks shall be arrived at by applying deduction of 50% to allow for voids in stacks. If some of the net quantity of two kinds of rocks exceeds the total quantity of the excavated materials, the quantity for each type of rock shall be worked out from the total quantity in the ratio of net quantities in stack measurements of two types of rocks. If in the opinion of the Engineer-in-charge, stacking is not feasible, the quantity of ordinary and hard rock shall be worked out by means of cross sectional measurements.
- 1.2.5.3 Where soil, ordinary rock and hard rock are mixed, the measurement of entire excavation shall be made as specified in Para 1.2.5.1 and 1.2.5.2 Excavated materials comprising hard rock and ordinary rock shall be stacked separately, measured and each reduced by 50% to avoid for voids to arrive at the quantity payable under hard rock and ordinary rock. The difference between the entire excavation and the sum of quantities payable under hard rock and ordinary rock shall be paid for as excavation in ordinary soil or hard soil as the case may be.
- 1.2.5.4 Where it is not possible for convenient to measure the depth of cutting by recording levels as specified in 1.2.5.1 the quantity of excavation shall be worked out from filling. The actual measurements of the fill shall be calculated by taking levels of the original ground before start of the work after site clearance and after compaction of the fill as specified and the quantity of earthwork so computed shall be reduced by 10% in case of consolidated fills by light mechanical machinery 5% in case the consolidation by the heavy mechanical machinery as per clause 1.1.12 to arrive at the net quantity of excavation for payment. No such deduction shall, however, be made in case of

consolidation by the heavy mechanical machinery at optimum moisture content, or when the consolidated filling is in confined situation such as under floors.

1.3.0 EARTH WORK IN CUTTING & FILLING / EMBANKMENT

1.3.1 Scope :

This covers specification for execution of earthwork required in cutting, filling and embankment. The earthwork for foundation of buildings/ structures, pipeline works and earthwork involving blasting is excluded.

1.3.2 Site clearance:

Before the earthwork is started, the area covering under cutting and filling shall be cleared of shrubs, vegetation, grass, trees, saplings and rubbish and removed outside the premises. The roots of trees shall be removed to a minimum of 60 cm below ground level of 15 cm below foundation level whichever is lower and the hollows filled up with earth leveled and rammed.

1.3.3 Setting out & Making Profiles

Masonry pillars shall be erected at suitable points to serve as benchmarks. These benchmarks shall be connected with GTS or any other permanent benchmark approved by the Engineer. The necessary profiles shall be set out. The levels shall be recorded in field books and plotted on plan, which shall be signed, by the contractor and the CLIENT Engineer before the earthwork is started. The labour required for taking levels shall be supplied by the contractor at his cost. The leveling instruments will be made available by the contractor.

1.3.4 Cutting and Filling :

The earth from cutting shall directly be used for filling. Filling shall be done in regular horizontal layers of not more than 225mm. The earth shall be free from all roots, grass and rubbish. Each layer shall be well consolidated by ramming watering shall be done if stipulated. The top surface of the finally finished area shall be neatly dressed. All cutting shall be done to the required levels.

1.3.5 Classification of Earthwork :

The earthwork shall be classified under the following categories:

- a. All kinds of soil except containing –50 percent or more of Kankar moorum or / and shingle saturated soil and rock.
- b. Kankar moorum or / and shingle: The soil containing 50 percent or more of Kankar moorum of and shingle shall be classified under this item. The decision of the Engineer in matter of classification of this soil shall be final and binding on the contractor brick ballast and mud concrete.
- c. Saturated soil: All kinds of soil except rock, below the sub-soil and water level shall be classified as “Saturated Soil”.
- d. Hard rock: This shall all rock, which in the opinion of the SPTI Engineer requires the use of blasting or chiseling for its excavation.

1.3.6 Lead and Lift

The rate for excavation include carrying of excavated material within the CLIENT premises wherever required for filling work as directed by the site Engineer. All surplus earth after filling work shall be disposed out of the CLIENT premises at no extra costs.

1.3.7 Measurement :

Filling sides of foundations:

The cubical contents of bed concrete leveling course and masonry / concrete in foundations up to the ground level shall be worked out and the same deducted from the cubical contents of earthwork in excavation for foundations already measured under the respective item of earthwork to arrive at the quantity of filling sides of foundation. The quantity shall be calculated correct to two places of decimal.

Filling in plinth and under floors

Depth of filling shall be the consolidated depth. The dimensions of filling shall be on the basis of pre – measurement correct to the nearest and cubical contents worked out in cubic meters correct to two places of decimal.

1.4.0 SAND FILLING IN PLINTH

Sand:

Sand shall be clean and free from dust, organic and foreign matter and its grading shall be within the limits of grading zone IV or V.

Filling

Sand filling shall be done in a manner similar to earth filling in plinth as specified earlier. Except that consolidation shall be done by flooding with water. The surface of the consolidated sand filling shall be dressed to the required level or slope and shall not be covered till the Engineer-in-charge has inspected and approved of the sand filling.

1.4.1 Measurements

The length, breadth and depth of consolidated sand shall be measured with steel tape correct to the nearest cm and cubical contents worked out in cubic meter correct to two places of decimal.

2. CONCRETE IN FOUNDATION

2.0.1 Scope

The construction of simple types of spread foundations ,heavy foundation such as wide strip foundations, raft foundations as required by the design and drawings are covered in this specification.

2.1.0 Materials

2.1.1 Cement: This shall be ordinary port land cement conforming to (IS 8112).

2.1.2 Coarse Aggregate: This shall conform to IS 383 specification for coarse and the fine aggregate from natural sources for concrete. Hard broken stone as coarse used, as coarse aggregate shall be of size not less than 40mm.

2.1.3 Sand: This shall mean a fine aggregate conforming to IS 383.

2.1.4 The sand shall clean, strong, granular and composed of hard siliceous materials. It shall be free from harmful impurities such as mica, shale or similar laminated materials, salts, alkalis and organic matter.

Pit sand, fresh water, river or lake sand is preferable. Sea sand, if used, shall be thoroughly washed to remove salt content. Sea sand must be tested for organic impurities and salt.

2.1.5 Water: Water used for making mortars and concrete shall be clean and free from injurious amounts of deleterious materials. Generally, potable water is considered suitable.

2.1.6 Cement Concrete: The concrete shall be proportioned and mixed laid down in IS 456 (revised). Reinforcement concrete work shall be executed in accordance with IS 456 (revised).

2.2.0 PREPARATION FOR CONCRETING

After excavation the bottom of the excavation shall be cleared of all loose soil rubbish and shall be leveled. Where necessary the bed shall then be wetted and compacted by heavy rammers to an even surface.

2.3.0 PROPORTIONING

Proportioning shall be done as required by the mix design for concrete. Boxes of suitable size shall be used for measuring sand and ballast. The size of the boxes shall be such as to suit batch of one bag of cement in the proportion of the mix. While measuring ballast shaking, ramming or hammering shall not be done.

2.4.0 CONCRETE

The concreting shall be laid in position in layers not exceeding 15 cms. The concrete shall not be thrown from a height but gently placed in such a way that segregation does not occur. Each layer shall be well rammed with wooden rammers until the mortar creams to the surface. No water shall be added during ramming but the surface of each layer shall be wetted and well scoured with trowel and wire brushes before the next layer is added. No ramming shall be done after the cement has commenced to set. During cold weather concrete shall not be done when temperature falls below 4° C (40° F) The concrete shall be protected against frost by suitable covering. Concreting damaged by frost

shall be removed and work re-done. During hot weather precaution shall be taken to see that the temperature of concrete does not exceed 38°C (100°F). No concrete shall be laid within half an hour of the closing time of the day unless permitted by the Engineer-in-charge.

2.5.0 CURING:

After the concrete has began to harden i.e. about after its laying it shall be protected from drying with moist gunny bags canvas or any other material approved by HLL Engineer-in-charge. After 24 hours of laying concrete the surface shall be case by flooring with water of minimum 2.5 cms depth or by covering with wet absorbent materials. The curing shall be done for a minimum period of 10 days. On the foundation concrete the masonry work may be started after 72 hours of its laying, but the curing of cement shall be continued along-with the masonry of work for a minimum period of 10 days.

2.5.1 MEASUREMENT :

Dimensions of length, breadth and thickness shall be measured correct to nearest cm. Except for the thickness of slab and partition which shall be measured to nearest 5mm. Areas shall be worked out to nearest 5mm and the cubic contents of consolidated concrete shall be worked out to nearest 0.001 cubic meters. Any work done in excess over the specified dimension or sections shown in the drawing or as required by the Engineer-in-charge is ignored.

3. CONTROLLED CONCRETE

Mix design for the controlled concrete shall be approved by HLL Engineer-in-charge 21 days before commencement of work.

- 3.1.1 (i) All concrete used for structural application shall be controlled grade Concrete: The concrete shall be designated by the works cube strength KG /sq cm at twenty eight (28) days evaluated as per clause 3.1.2 below. Thus, concrete designated as M 250 and M 300 shall mean concrete having works cube strength of 250 kg / sq cm and 300 kg / sq cm respectively of twenty eight (28) days.
- (ii) Mix proportions used for a particular designation of concrete shall be based on the results of preliminary tests carried out on samples of materials proposed for use in the works. Any of the recognized methods of mix design such as Road Note No.4 (EMSO London) or any other approved method may be used in the design of trial mixes. Trial mixes shall take into consideration the workability required at site for placing the concrete in the structure.
- (iii) Preliminary tests will have to be made if the source of the materials change or any changes in mix proportions is to be made in the course of construction.

- (iv) Minimum cement content required in reinforced cement concrete to ensure durability under specified conditions of exposure will be in accordance with the latest revision of IS 456
- (v) All controlled grade concrete shall be compacted by mechanical vibration.

3.1.2 Preliminary Test

- i) The cube strength of concrete as observed during the preliminary test carried out under laboratory conditions shall have a minimum value of as mentioned in with the latest revision of IS: 456.
- ii) The preliminary tests shall be conducted as per Clause 2 of IS: 516 – 1959 on 15 cms x 15 cms. Cubes. Each preliminary test shall consist of 3 sets of separate tests consisting of 6 specimens of each test, 3 shall be tested at 7 days and remaining 3 at 28 days. The average 28 days strength of each test shall satisfy the strength requirement of the previous paragraph. In addition, not more than one specimen from all the three tests shall have strength lower than 90% of the specified works cube strength.

3.1.3 Works Cube Tests

- i) Test specimens for works cube tests shall be secured, prepared and tested generally in accordance with IS: 516 cubes shall preferably be cast near the point of placing the concrete and shall be cured in a manner identical to the method used for curing the structural member, the concrete of which they represent.
- ii) The minimum frequency of sampling of concrete of each grade shall be in accordance with the following :

Quantity of concrete in the works Sqm.	Number of Samples
1-5	1
6-15	2
16-30	3
31-50	4
51 and above	4 plus one Additional sample for each additional 50 sqm or part thereof.

Note: At least one sample shall be taken from each shift.

- iii) At least half the number of the cubes prepared shall be tested at 28 days in an approved laboratory at the contractor's cost. The balance half may be tested at 7 days and after a suitable correlation between 7 days & 28 days tests has been established at site, the 7 days test may be used as an indication of trends in the quality control of concrete.

- iv) The criteria for acceptance of the test results shall be as per IS 456.

3.1.4 Water – Cement – Ratio and Workability

- i) The quantity of mixing water shall be controlled throughout the works. At least one determination of moisture content shall be made every day, preferably just before commencement of the concreting work. Determination of moisture content of the aggregate shall follow the procedure given in IS – 2386 'Methods of Test for / aggregate for concrete; Part –III, Specific Gravity Density, Voids Absorption and Bulking'.
- ii) At least one test for workability shall be done for every 30 cm of concrete cast per pour or per day, whichever is less.

3.1.5 Batching & Mixing :

- i) All materials shall be batched by weight, except water which may be measured by volume in graduated containers Cement shall be weighed separately. The accuracy of all weighing devices shall be maintained within (one) 1% and the devices shall be checked periodically as directed by the Architect. The weigh batching machine shall be Heatley Gresham or of other approved make.
- ii) Cumulative batching of materials may be permitted provided the method of measurement gives the above specified accuracy.
- iii) All machines and methods used for batching shall be subject to the approval of the Architect.
- iv) Aggregate shall be handled from the stock piles to the batching plant / mixer in such a manner as to prevent segregation. Aggregates shall not get mixed with earth or any foreign matter during the handing process.
- v) An approved type of weigh- batcher shall be used for proportioning the ingredients at the mixer for all controlled concrete. Accuracy of weigh batcher as required in clause 3.1.0 (I) shall be checked periodically and at least once a week.
- vi) Proportioning of aggregates for ordinary grade concrete, proportioned by volume may be done in batch boxes of size which are multiples of 35 liters which shall be assumed volume of one 50 Kg per bag of cement. Cement shall be batched in this case in bag lots. All batch boxed shall be checked periodically and at least once a week of accuracy of dimensions. Water of controlled concrete and ordinary grade concrete may be measured in graduated container.
- vii) Mechanical batch mixers shall be used for mixing all concrete. Use of manual mixing shall not be permitted for any type of concrete. Mixers shall conform to IS: 1791.

- viii) The content of the hopper shall be emptied in one operation into the drum of the mixer taking care to prevent loss of cement by being blown away in high wind. At the start of the day, when some mortar is likely to adhere to the walls of the drum and blades and cause the mixed batch to be harsh and stoney, the proportionate of course aggregate shall be slightly reduced for the first one or two batches.
- ix) The batch shall be so charged into the mixer that some water will enter in advance of the cement and the aggregates. Water shall continue to flow for a period which may extend to the end of the first 25 percent of the specified mixing time.
- x) Each batch shall be mixed thoroughly until the mix achieves uniform colour and consistency. In no case shall the mixing time, reckoned from the time all the material from the hopper has entered the drum be less than 1½ minutes.
- xi) The drum shall be completely emptied before the next batch is introduced.
- xii) The adequate mixing capacity shall be provided at the site so as to deliver continuously the required quantities of concrete for a pour. Quantity of material mixed per batch shall not exceed manufacturers rated capacity.
- xiii) All the mixers shall be maintained clean and the pickup and throw over blades in the drum shall be replaced when they have lost 10% of their original depth.

3.2.0 Form works :

3.2.1 Shuttering shall be either of wooden planking of 3 cm minimum thickness with or without steel sheet lining or of steel plates stiffened by steel angles. The shuttering shall be supported on battens and beams and props of vertical battens properly cross braced together so as to make the form work rigid. In place of balli props, brick pillars of adequate section and shall have camber so that it assumes correct shape after the deposition of the concrete and shall be able to resist forces caused by vibration of live load of men working over it and other incidental loads associated with it. The shuttering shall have smooth and even surface and its joints shall not permit leakage of cement grout.

3.2.2 Propping or centering

The props shall consist of ballies having 10 cm minimum dia measured at mid length and 8 cm at thin end and shall be placed at 1 to 25 m spacing. These shall rest squarely on wooden sole plates of 4cm thickness and minimum bearing area of 0.1 sqm laid on ground. Double wedges shall further be provided between the sole plate and the wooden prop so as to facilitate tightening and easing of centering and shuttering without jamming the concrete. Preferably tubular centering should be used.

3.2.3 Shuttering :

The timber used in shuttering shall not be so dry as to absorb water from concrete and swell and bulge, nor so green or wet as to shrink after erection. Kailwood or such other kind of timber, which is not affected appreciably by its contact with water, shall be used. The timber shall be accurately sawn and planed on the sides and the surface in contact with concrete. Wooden formwork with sheet metal lining or steel plates stiffened by steel angles shall also be permitted.

The chamfers, beveled edges and moulding shall be made in the form itself. Openings for fan clamps and other fittings connected with services shall be provided in the shuttering as directed by the site engineer.

As far as practicable, clamps shall be used to hold the forms together and use of nails and spikes avoided. Where the use of nails is unavoidable there shall be left projecting so that they can be easily drawn.

3.2.4 Surface treatment for shuttering :

The surfaces of timber shuttering that would come in contact with concrete shall be well wetted and coated with soap solution before the concreting is done. Soap solution for this purpose shall be prepared by dissolving yellow soap in water to get the consistency of paint. Alternatively, a coat of raw linseed oil or from oil of approved manufacture may be applied in place of soap solution. In case of steel shuttering either soap solution or raw linseed oil shall be applied after thoroughly cleaning the surface.

3.2.5 Camber

The shuttering for beams and slabs shall have camber (1 to 240) or as directed by the site engineer so as to off set the subsequent deflection. For cantilevers the camber at free end shall be $1/28^{\text{th}}$ of the projected length or as directed by the site engineer.

3.2.6 Assemblage of forms and their striking

The forms shall be as assembled as to facilitate easing the removal of their various parts in proper sequence without jamming the concrete. In a slab and I beam construction sides shall be stripped first, then the under side of slab and lastly that the beam.

Forms shall be eased carefully in order to prevent the load being suddenly transferred to concrete. The period that shall elapse after concrete has been laid before easing and removal of centering and shuttering in under taken shall be followed as per IS 456.

In the circumstances and where OPC is used forms may generally be removed after the expiry of the following periods:-

- a. Walls, Columns & Verticals faces of all Structural members -24 to 48 hours as may be decided by Engineer-in Charge.
- b. Slab
 - i. Spanning up to 4.5m 7 days
 - ii. Spanning up to 4.5m 14 days
- c. Beams and arches
 - i. Spanning up to 6m 14 days
 - ii. Spanning over 6m and up to 9m 21 days
 - ii. Spanning over 9m 29 days

4. READY MIXED CONCRETE :

- 4.0.1 This shall be prepared by mixing graded stone aggregates with specified fine aggregate, cement, water and admixture as per mix design and conforming to SI 10262 – 1982(Revised) and shall be approved by Architects.

Water shall conform to IS 3025

Cement shall be cement conforming to IS 8112.

Aggregates shall be coarse stone aggregates shall conform to IS 383.

Fine shall be natural sand. It shall be hard, durable and chemically inert clean and free from adherent coatings, organic matter, etc., and shall not contain any appreciable amount of clay balls or pallets and harmful impurities e.g. Iron pyrites, alkalies, salts, coal, mica, shale or similar laminated materials in such form or in such quantities as to cause corrosion of metal or adversely affect the hardening the strength, durability of the concrete.

The maximum content of the silt should not exceed 2%.

4.0.2 Batching:

To avoid confusion and error in batching, consideration should be given to using smallest practical number of different concrete mixes, the quality of both cement and aggregate shall be determined by mass; admixture, if solid, by mass; liquid admixture may however be or measured by volume in calibrated tank (Refer IS 4925).

Ready – mixed concrete supplied by ready-mixed concrete plant shall be preferred. For large and medium project sites the concrete shall be sourced from ready-mixed concrete plants or from on site or of site batching and mixing plants (Refer IS 4926).

If found necessary, it can be shown to the satisfaction of the Engineer-in-charge that supply of properly graded aggregate of uniform quality can be maintained over a period of work, the grading of aggregate should be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions when required, the different sizes being stocked in separate stock-

piles. The material should be stock piled for several hours preferably a day before use. The grading of coarse and fine aggregate should be checked as frequently as possible, the frequency for a five being determined by the Engineer-in-charge to ensure that the specified grading is maintained.

If required by the engineer-in-charge, the accuracy of the measuring equipment shall be maintained within ± 2 percent of the quantity of cement being measured and with ± 3 percent of the quantity of aggregate, admixtures and water being measured.

Proportion / Type and grading of aggregates shall be made by that in such a way so as to obtain densest possible concrete. All ingredients of the concrete should be used by mass only.

The RMC supplier shall maintain the water – cement ratio constant as its correct value. To this end, determination of moisture contents in both fine and coarse aggregates shall be made as frequently as possible the frequency for a given job being determined by the Engineer-in-charge according to weather conditions. The amount of the added water shall be adjusted to compensate for any content in the aggregates, IS 2386 (Part 3) shall be referred to. To allow for the variation in mass of aggregate due to variation in their moisture content. Suitable adjustments in the masses of aggregates shall also be made.

No substitutions in materials used on the work or alterations in the established proportions shall be allowed.

4.0.3 Mixing :

Concrete shall be mixed in a mechanical mixer. The mixer should comply with IS 1791 and IS 12119. The mixers shall be fitted with water measuring (metering) devices. The mixing shall be continued until there is uniform distribution of the materials and the mass is uniform in colour and consistency if there is segregation after unloading from the mixer, the concrete should be remixed.

For guidance, the mixing time shall be at least 2 minutes. For other types of more efficient mixers, manufacturer recommendations shall be followed. Workability should be checked at frequent intervals (refer IS 1199).

Dosages of retarders, plasticisers, and superplasticisers shall be restricted to 0.5.1.0 and 2.0 percent respectively by weight of cementitious materials and unless a higher value is agreed upon between the manufacturer and constructor based on performance cost.

4.0.4 Formwork :

As given in concrete specifications, however the formwork shall in addition to this shall be designed for extra vibration / impact/ point load if the RMC is laid by the method of pumping.

4.0.5 Transporting, placing, compaction and curing

4.0.5.1 Transporting and handling

After mixing, concrete shall be transported to the formwork as rapidly as possible by methods which will prevent the segregation or loss of any or the ingredients or ingress of foreign matter or water and maintaining the required workability.

During hot or cold weather, concrete shall be transported in deep containers other suitable methods to reduce the loss of water by evaporation in hot weather and heat loss in cold weather may also be adopted.

4.0.5.2 Placing :

The concrete shall be deposited as nearly as practicable in its final position to avoid rehandling. The concrete shall be placed and compacted before initial setting of concrete commences and should not be subsequently disturbed. Methods of placing should be such as to preclude segregation. Care should be taken to avoid displacement of reinforcement or movement of formwork. As a general guidance, the maximum permissible free fall of concrete may be taken as 1.5m.

4.0.5.3 Compaction.

Cement shall be thoroughly compacted and fully worked around the reinforcement, around embedded fixtures and into corners of the formwork.

Concrete should be compacted using mechanical vibrators complying with IS 2505, IS 2506, IS 2514 and IS 4656. Over vibration and under vibration of concrete are harmful and should be avoided. Vibration of very wet mixtures should also be avoided.

Whenever vibration has to be applied externally the design of formwork and the disposition of vibrators, should receive special consideration to ensure efficient compaction and to avoid surface blemishes.

4.0.5.4 Curing

Curing is the process of preventing the loss of moisture from the concrete whilst maintaining a satisfactory temperature regime. The prevention of moisture loss from the concrete is particularly important if the water cement ratio is low, if the cement has a high rate of strength development, if the concrete contains granulated blast furnace slag or pulverized fuel ash. The curing regime should also prevent the development of high temperature gradients within the concrete.

The rate of strength development at the early ages of concrete made with super sulphated cement is significantly reduced at lower temperature. Super sulphated super concrete is seriously affected by inadequate cleaning and the surface has to be kept moist for at least 7 days.

4.0.5.5 Moist curing

Exposes surfaces of concrete shall be kept continuously in a damp or wet condition by ponding or by covering with layer of sacking, canvas, hessian or similar materials and kept constantly wet for at least 7 days from the date of placing concrete in case of ordinary Portland cement and at least 10 days where mineral admixture or blended cement are used. The period of curing shall not be less than 10 days for concrete exposed to dry and hot weather conditions, in the case of concrete where mineral admixture or blended cement are used it is recommended that above minimum periods may be extended to 14 days.

4.0.5.6 Membrane Curing

Approved curing compounds may be used in lieu of moist curing with the permission of Engineer-in-charge such compounds shall be applied to all exposed surfaces of concrete as soon as possible after the concrete has set. In permeable membrane such as polyethylene sheeting covering closely the concrete surface shall also be used to provide effective barrier against evaporation. The activity needs specific approval of the competent authority.

4.0.6 Construction Joints and Cold Joints :

Joints are a common source of weakness and therefore it is desirable to avoid them. If this is not possible their number shall be minimized concreting shall be carried out continuously upto construction joints, the position and arrangement of which shall be indicated by the designer construction joints should comply with IS 11817.

Construction joints shall be placed at accessible location to permit cleaning out of laitance, cement slurry and unsound concrete in order to create rough / uneven surface. It is recommended to clean out laitance and cement slurry by using wire brush on the surface of joint immediately after initial setting of concrete and to clean out the same immediately thereafter. The prepared surface should be in clean saturated surface dry condition when fresh concrete is placed, against it. In the case of construction joints at locations where the previous pour has been cast against shuttering the recommended method of obtaining a rough surface for the previously poured concrete is to expose the aggregate with a high pressure water jet or any other appropriate means.

Fresh concrete should be thoroughly vibrated near construction joints so that water from the new concrete flows between large aggregates and develop proper bond with old concrete.

Where high shear resistance is required at the construction joints, shear keys may be provided.

Sprayed curing membranes and release agents should be thoroughly removed from the joint surface.

4.0.7 Supervision

It is exceedingly difficult and costly to alter concrete once placed. Hence constant and strict supervision of all the items of construction is necessary

during the progress of the work, including the proportioning and mixing of concrete. Supervision is also of extreme importance to check the reinforcement and its placing before being covered.

Before any important operation, such as concreting or striping of formwork is started adequate notice shall be given to the Engineer-in-charge.

4.1.0 Admixture

Admixture, if used shall comply with IS 9130. Previous experience with and data on such materials should be considered in relation to the likely standards of supervision and workmanship to the work being specified.

Admixture should not impair durability of concrete nor combine with the constituent to form harmful compounds nor increase the risk of corrosion of reinforcement.

The workability, compressive strength and the slump loss of concrete with and without the use of admixtures shall be established during the trial mixes before use of admixtures.

The relative density of liquid admixtures shall be checked for each drum containing admixtures and compared with the specified value before acceptance.

The chloride content of admixtures shall be independently tested for each batch before acceptance.

4.2.0 Workability of concrete :

The concrete mix proportions chosen should be such that the concrete is of adequate workability for the placing conditions of the concrete and can properly be compacted with the means available. Suggested ranges for workability of concrete measured in accordance with IS 1119 as given below

Placing Conditions	Degree of workability	Slump (mm)
Blinding concrete shallow sections, pavements using pavers	Very low	Refer IS 456
Mass concrete; lightly reinforced sections in slabs, beams, walls, columns, floors hand placed pavements, canal lining, strip footings.	Low	25-75
Heavily reinforced sections in slabs, beams, walls, columns, slip form work; pumped concrete	Medium	50-100 75-100
Trench fill, In – situ piling	High Very high	100-150

Note: For most of the placing conditions, internal vibrators (needle vibrators) are suitable. The diameter of the needle shall be determined based on the density and spacing of reinforcement bars and thickness of sections. For termite concrete, vibrators are not required to be use.

4.3.0 Concrete Mix Proportioning

4.3.1 Mix Proportion

The mix proportions shall be selected to ensure the workability of the fresh concrete and when concrete is hardened, it shall have the required strength durability and surface finish.

The determination of the proportions of cement aggregates and water to attain the required strength shall be made as per IS 10262 – 1982 (Revised) as follows:

- a. By designing the concrete mix, such concrete shall be called “Design Mix Concrete”.
- b. By adopting nominal concrete mix such concrete shall be called nominal concrete.

Design mix concrete is preferred to nominal mix. if design mix concrete cannot be used for any reason on the work for grades of M20 or lower, nominal mixes may be used with the permission of the Engineer-in-charge, which however is likely to involve a higher cement content.

4.3.2 Information required :

In specifying a particular grade of concrete, the following information shall be included:

- a. Type of mix, that is, design mix concrete or nominal mix concrete.
- b. Grade designation
- c. Type of cement
- d. Maximum nominal size of aggregate
- e. Maximum cement content (for design mix concrete).
- f. Maximum water cement ratio
- g. Workability
- h. Mix proportion (for nominal mix concrete)
- i. Exposure conditions
- j. Maximum temperature of concrete at the time of placing
- k. Method of placing
- l. Degree of supervision

In appropriate circumstances, the following additional information may be specified:

- a. Type of aggregate
- b. Maximum cement content and

- c. Whether an admixture shall or shall not be used and the type of admixture and the condition of use.

4.3.3 Design Mix Concrete :

As the guarantor of quality of concrete used in the construction the contractor shall carry out the mix design and mix so designed (not the method of design) shall be approved by Architects within the limitations of parameters and other stipulations lay down by IS standard.

The mix shall be designed to produce the grade of concrete having the required workability and characteristic strength not less than appropriate values given table. The target means strength not less than appropriate values given in table. The target mean strength of concrete mix should be equal to the characteristic strength plus 1.65 times of standard deviation.

Mix design done earlier not prior to one year may be considered adequate for later work provided there is no change in source and the quality of the materials.

4.3.4 Standard Deviation

The standard deviation of each grade of concrete shall be calculated if required by the competent authority of CLIENT – separately.

Standard deviation based on test strength of sample:

- a. Number of test results of samples. The total number of test strength of samples required to constitute an acceptable record for calculation of standard deviation shall be not less than 30. Attempts should be made to obtain the 30 samples, as early as possible, when a mix is used for the first time.
- b. In case of significant changes in concrete – when significant changes are made in the production of concrete batches (for example changes in the materials used, mix design equipment or technical control), the standard deviation value shall be separately calculated for such batches of concrete.
- c. Standard deviation to be brought up to date- The calculation of the standard deviation shall be brought up to date after every change of mix design.

4.3.5 Assumed standard deviation

Where sufficient test results for a particular grade of concrete are not available the value of standard deviation given in table of IS :456 (revised) may be assumed for design of mix in the first instance. As soon as the results of samples are available, actual calculated standard deviation shall be used and the mix design properly.

However, when adequate past records for a similar grade exists and justified to the designer a value of standard deviation different from that shown in the table IS: 456 (revised), it shall be permissible to use the value.

Grade of concrete	Assumed standard deviation N/sqm
M 10, M15	3.5
M 20, M25	4
M 30, M 35, M40, M45, M50	5

4.3.6 Acceptance Strength

Compressive strength

The concrete shall be deemed to comply with the strength requirements when both the following conditions are met:

- The mean strength determined from any group of four consecutive test results complies with the appropriate limits in col2 of table 11 of IS 456 (revised).
- Any individual test result complies with the table 11 col 3 to IS 456 (revised).

4.3.6.1 Quantity of concrete represented by strength test result :

The quantity of concrete represented by a group of four consecutive test results shall include the batches from which the first and last samples were taken together with all intervening batches.

For the individual test results requirements given in IS: 456 (revised) above, only the particular batch from which the sample was taken shall be at risk.

Where the mean rate of sampling is not specified, the maximum quantity of concrete that four consecutive test results shall be limited to 60 cum.

If the concrete is deemed not to comply pursuant to the above, the structural adequacy of the parts affected shall be investigated and any consequential action as needed shall be taken.

Concrete of each grade shall be assessed separately.

Concrete is liable to be rejected if it is porous or honey combed, its placing has been interrupted without providing a proper construction joint, the reinforcement has been displaced beyond the tolerances specified, or construction tolerance have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of CLIENT competent authority.

4.4 DAMP PROOF COURSE

4.4.1 SCOPE

This covers damp proof course for building works.

MATERIALS: Damp proof course shall consist of cement, sand and stone aggregate of specified proportion and thickness. Approved water proofing compound shall be added as per instructions of the manufacturers. The cement shall be ordinary Portland cement conforming to IS 269. The sand shall be clean, coarse of 5mm size and down and the stone aggregate shall be hard and tough of specified gauge.

MIXING: Mixing shall be done on a masonry platform or iron tray with measuring boxes. The cement is thoroughly mixed with water proofing compound to the required quantity and then be mixed dry with stone aggregate in the specified proportion. Clean water shall then be added to get the required workable consistency.

LAYING: The concrete shall be laid within half an hour mixing and compared thoroughly by tamping and leveled both ways. After two hours of laying the surface of concrete shall be made rough. The damp proof course shall be laid in continuation in one day without any joints. Joints, if unavoidable, shall be given at the still of doors or openings.

4.4.2 CURING: The DPC shall be cured at least for seven days.

4.4.3 PAINTING WITH BITUMEN:

One coat of bitumen of 80 /100 grade shall be applied on the upper surface of DPC, if specified, at the rate of 1.5 Kg. per sqm. The painted surface shall be blended immediately with coarse sand.

4.4.4 Measurement

This shall be measured in square meters stating the thickness.

5.0 STONE MASONRY

5.0.1 Scope :

This covers the construction in stone masonry in general. The stone masonry work shall be done confirming to IS 1597 (Part 1) 1992.

5.1.0 Materials :

Unless otherwise specified, stones shall conform to requirements of IS 1121 and 1124. Mortar or masonry shall be prepared in accordance with IS 2250 cement shall be ordinary Portland cement conforming to IS 8112. Sand shall mean a fine aggregate which shall pass through a IS sieve No. 480 (3/16" in B.S) test sieve leaving residue not more than 5%.The sand shall be clean, strong, granular and composed of hard siliceous material. It shall be free from harmful impurities such as mica, shale or similar laminated materials, salts, alkalis and organic mater. Pt sand, fresh water, river or lake sand is preferable. Sea sand if used must be tested for organic impurities and salt and can be permitted only after written permission of Architects water used for mortar shall

be clean and free from injurious amounts of deleterious materials potable water is generally suitable.

5.2.0 RANDOM RUBBLE MASONRY

5.2.1 Stone

Stone shall be of the type specified such as granite, trap, lime stone, sand stone, quartzite etc., and shall be obtained from the quarries. It shall be hard, sound, durable and free from decay and weathering, free from defects like cavity, 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 stone of uniform colour, quality or texture, generally stones cannot contain crypts, crystalline, silica or chart mica and other deleterious materials like iron oxide, organic impurities etc., shall be obtained from an approved quarry stone with round surface shall not be used.

5.2.2 Dressing

Stone shall be hammer dressed on the face, the sides and the beds to enable it to come into close proximity with the neighboring stone. The "brushing" in the face shall not project more than 4 cm on an exposed face and 1 cm on a face to be plastered.

5.2.3 Laying :

All stones shall be wetted before use. The walls shall be carried up truly plumb or to specified batter. Every stone shall be carefully fitted to the adjacent stones so as to form near and close joints. Stones may be laid at random without being brought up to any level course except at plinth, window sill and roof level. The bond shall be obtained by fitting in closely the adjacent stones and by using bond stones.

Face stones shall extend and bond well into the backing. These shall be arranged to break joints as such as possible, and to avoid long vertical lines of joints. Their height shall not be greater than the breadth at the face or the depth inwards. The hearting or interior filling of the wall face, shall consist of rubble stones, not less than 13 cm in any direction, carefully laid, hammered down with a wooden mallet into position and solidly bedded in mortar; chips and spawls of stone used wherever necessary to avoid thick mortar, chips and spawls of the same time ensuring that no hollow spaces are left anywhere in the masonry. The hearting will be laid nearly level with facing and backing except that at about one meter intervals, vertical "Plums" projecting about 15 to 20 cm shall be firmly embedded to form a bond between successive courses. The chips shall not be below the hearting stones to bring these up to the level of face stones. The use of chips shall bring these up to face stones. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and these shall not exceed 20% of quantity of stone masonry.

The masonry in a structure shall be carried out simultaneously, where the masonry of one part has to be delayed the work shall be raked back at an angle not exceeding 45°. Toothing in masonry shall not be allowed.

5.2.4 Bond Stones

Bond or through stones running right through the thickness of walls shall be provided in walls up to 60 cm thick. If the walls are more than 60cm thick, two or more bond stones over lapping each other by at least 15cm shall be provided in a line from face to back. At least one bond stone or a set of bond stones shall be provided for every 0.5 sqm of wall surfaces.

5.2.5 Quoins

The quoins shall be of selected stones neatly dressed with the hammer or chisel to form the required angle and laid header and stretcher alternately. No quoin stone shall be less than 0.01 cum meter in volume. Height of quoins and jabs stones shall not be less than 15cms.

5.2.6 Joints

Stones shall be so laid that all joints are full of mortar. Face joints shall not be more than 2.5 cm thick.

When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, the joints shall be raked to a minimum depth of 2 cm by raking tool during the progress of work, when the mortar is still green.

5.2.7 Curing

Same as stated in the technical specifications of brick masonry.

5.2.8 Scaffolding

For this class of work, single scaffolding having one set of vertical support shall be provided. The supports shall be sound and strong, tied together by horizontal pieces, over which the scaffolding planks shall be fixed. The inner end of the horizontal scaffolding member may rest in a hole provided in the masonry. Such holes, however, shall not be allowed in pillar under one meter in width or near the skewbacks or arches. The holes left in masonry work for supporting scaffolding, shall be filled and made good with concrete 1:4:8 before plastering. The measurement shall conform to IS 1200 (Part IV).

5.2.9 Measurement

The length, height and thickness shall be measured correct to a centimeter, the thickness of wall shall be measured at joints excluding the bushing only specified dimension shall be allowed and anything else shall be ignored. The

quantity shall be calculated in cubic meter nearest to two places of decimal. The work under following categories shall be measured separately.

- a. From foundation to plinth level (Level 1)
- b. From plinth level to floor II level
- c. From floor II level to floor III level and so on.
- d. Stone masonry in parapet shall be measured together with a corresponding items in the wall of the storey next below.

No deduction shall be made nor did extra payment make for the following:

- i. Ends of dissimilar materials (i.e. joists, beams, lintels, posts, girder, rafters, purlins, trusses, corbels, steps etc.) up o 0.1 sqm in section.
- ii. Openings each up o 0.1 sqm in area. In calculating the area of openings, any separate lintels or sills shall be included along with the size of opening but the end portions of the lintels shall be excluded and the extra width of rebated reveals, if any, shall also be excluded.
- iii. Wall plate and bed plates and bearing of chajjas and the like, where the thickness does not exceed 10 cm and the bearing does not extend over the full thickness of the wall.

NOTE: The bearing of floor and roof shall be deducted form wall masonry

- iv. Drain holes and recesses for cement concrete blocks to embed hold fasts for doors, windows etc.,
- v. Building in masonry, iron fixtures, pipes up o 300mm dia, hold fasts of doors and windows etc.,
- vi. Forming chases in masonry each up o section of 350 sq. cm.

Masonry (excluding fixing brick work) in chimney breast with smoke of air flues not exceeding 20sqdm (0.20 sqm) in sectional area shall be measured as solid and no extra payment shall be made for pargetting and coring such flues. Where flues exceed 20 sq dm (0.20 sqm) sectional areas, deduction shall be made for the same pargetting and coring flues shall be measured in running meters stating sizes of flues and paid for separately. Aperture for fire place shall not be deducted and no extra payment made for splaying of jambs and throating.

Aperture for fireplaces shall not be deducted and extra labour shall be measured for splaying of jabs, throating and making arch to support the opening.

5.3.0 COURSED RUBBLE MASONRY

5.3.1 Stone

Stone shall be as specified in para 5.2.1

5.3.2 Size of stone

Normally stone used shall be small enough to be lifted and placed by hand. Unless otherwise indicated, the length of stones for stone masonry shall not

exceed three times the height and the breadth or base shall be greater than $\frac{3}{4}$ of the thickness of the wall, or not less than 15 cm. The height of stone may be upto 30 cms.

5.3.3 Dressing

Same as random rubble masonry, except that no portion of dressed surface of joint shall exceed 10mm from straight edge plane on it.

5.3.4 Mortar

The mortar for jointing shall be as 10mm thick.

5.3.5 Laying

Shall be same as course rubble masonry except that, the use of chips shall not exceed 15% of quantity of stone masonry and stone in each course need not be of the same height but not more than 2 stones shall be used in the height of course.

5.3.6 Bond Stone, quoins :

Shall be as specified under para 5.2.4 and 5.2.5

5.3.7 Joint :

All bed joints shall be horizontal and all sides vertical. All joints shall be fully packed with mortar, face joints shall not be more than 2 cms thick. When plastering or pointing is not required to be done, the joints shall be struck flush and finished at time of laying. Otherwise the joints shall be raked to a minimum depth of 20mm by raking tool during progress of work, where the mortar is still green.

5.3.8 Curing, Scaffolding and measurements :

Shall be as specified under para 5.2.7 and 5.2.8.

6.0 BRICK MASONRY

6.0.1 General

This section covers the requirements for brick works in walls and partitions.

IS 2212 ' Code of Practice for Brick Work' shall apply in so far as it is applicable. The provisions of the following Indian Standard Specifications shall form a part of this specifications shall form a part of this specifications to the extent they been referred to or are applicable with this specification.

IS '8112' specification for 43 grade ordinary Portland cement.

IS '1077' specification for common burnt clay building bricks.

IS '3466' specification for masonry cement.

IS '2250' code of practice for preparation and use of Masonry Mortars.

6.1 Bricks

Bricks shall be as per the table below table moulded bricks (unless otherwise specified) uniform in colour and size as per table below and shall be of uniform shape and colour and shall be well burnt but not over burnt. They shall give a ringing metallic sound when struck with a mallet. When soaked in water for 24 hours, the bricks shall not absorb water more than 20% of its weight when dry. Bricks shall be soaked in water for at least 6 hours before use. Broken bits shall not be used except in closer.

REQUIREMENTS OF BURNT CLAY BRICKS

Class – 50 Bricks
GENERAL REQUIREMENTS : Shall have a uniform deep cherry red, or copper colour, shall be thoroughly burnt but not over burnt and regular in shape. Their edges must be straight square and the bricks must emit a clear ringing sound on being struck. They must free from cracks, chips, flaw and stones or lumps of any kind.
COMPRESSIVE STENGTH : Not less than 50 Kg / Sq Cm
Size : Nominal : 200x100x100mm Actual : 190x90x90 mm

6.2 Mortar

6.2.1 The mortar for brick masonry shall be composed of one part of cement and 6 parts of dry sand as specified by volume. The mortar for half brick walls shall be 1:4 proportions.

6.2.2 The unit measurement shall be standard bag of cement (50 Kgs) assumed to be 35 liter (0.035 cum). Sand shall be measured in boxes of suitable size. In case of damp sand, its quantity may be corrected for bulkage.

6.2.3 Mortar shall be mixed in mechanical mixers. However, where hand mixing is permitted by the Engineer-in-charge. Cement and sand shall be mixed together thoroughly on a clean dry platform until the mixture of to be obtain a mortar of a consistency of a stiff paste. Care being taken to add just sufficient water for the purpose.

6.2.4 Only that quantity of mortar shall be mixed as can be placed in the work within one hour of its mixing. Mortar unused for more than one hour from the time of mixing shall be rejected and removed from the site.

6.3 Workmanship

6.3.1 Only skilled and experienced masons shall be employed for laying masonry or brick work.

- 6.3.2 All bricks shall be thoroughly soaked in water for at least six (6) hours before they are placed in the work. At the time of laying, the surfaces shall be just moist but not to wet to cause dripping of water.
- 6.3.3 No bats or cut bricks shall be used in the work unless it is absolutely necessary around irregular opening or for adjusting the dimensions of different courses and for closer, in which case full bricks shall be laid at the corners, the bats being placed in the middle courses.
- 6.3.4 The bricks shall be laid in mortar to line, levels and shapes as shown in the drawings, slightly pressed and thoroughly bedded in mortar and all joints shall be properly flushed and completely packed with mortar so that no hollows are left. Edges of bricks shall not be damaged during handling. Vertical joints shall not come one over the other in the adjacent courses and shall not normally be nearer the one quarter of the brick length.
- 6.3.5 Fixtures, plug, frames for doors and windows etc., shall be placed in positions shown in the plan while laying the courses and not later by removal of bricks already laid.
- 6.3.6 Verticality of the walls and the horizontally of the courses shall be checked frequently by means of plumbs bobs and spirit levels respectively.

6.4 BOND

- 6.4.1 Unless otherwise specified in the plans or ordered by the Engineer-in-charge, English Bond shall be used.

6.5 JOINTS

- 6.5.1 Joints shall not exceed 100mm in thickness. All joints shall be stuck flush with the face when placing, for all the walls required plastered finished. Joints of brickwork shown to be exposed in the drawing shall be racked out not less than 10mm deep when the mortar is green to receive subsequent pointing treatment.

6.6 Rate of Raising

- 6.6.1 The brick masonry shall not be raised more than 60 cms per day and courses shall be raised in uniform height as far as possible. Where this is not possible, the bricks shall be stepped so as to enable the latter courses of masonry to bond with the former. The brick work shall be done in stages as directed by the Engineer-in-charge, to ensure that the load transmitted to the structure does not exceed that for which it has been designed.

6.7 Scaffolding

- 6.7.1 This may be double or single as warranted by the working conditions scaffolding maybe timber ballies, bamboos or tubular steel sections. All scaffolding shall be built of adequate strength to support at conceivable loads likely to come on them. Put long holes shall be made good by brick to match the face work and holes behind shall be made good by filling solidity with 1:4:8 cement concrete.

6.8 Curing

- 6.8.1 All brickwork when laid shall be initially protected against hot sun and drying winds of necessary, by covering with wet sacking or similar other absorbent material. The brickwork shall be kept wet for a period of at least 15 days after laying. At no time shall the mortar be allowed to dry.

6.9 Bad Work

- 6.9.1 Should the mortar perish, i.e become dry or powdery through neglect of watering or the masonry be hollow or the work done not according to plans and specifications, the work shall be pulled down and rebuilt, all at the contractors cost.

6.10 Tolerance

- 6.10.1 The maximum permissible tolerance in masonry should be as specified in IS 1969.

6.11 HALF BRICK WALLS

- 6.11.1 Half brick walls shall be constructed wherever shown in the drawing. These shall be all of stretches only and half brick shall not be used. The mortar to be use shall be cement sand mortar 1:4 and as per specification mentioned elsewhere. The work shall be carried out as per IS: 2212.
- 6.11.2 Reinforcement consisting of 2 bars of 6mm or flat as in the standard specification shall be provided at every fourth course. The MS bars shall be well anchored at the ends of the partition. These bars shall be fully embedded in mortar and overlaps if any shall be minimum 30 cms. And shall conform to specifications mentioned under 'STEEL REINFORCEMENT'.
- 6.11.3 Whenever the height of the wall is more than 2m and RCC runner shall be provided if so instructed by the Engineer-in-charge, at the rate of one runner for every 1.5 m height. The RCC runner reinforcement in that shall be paid separately. But the reinforcement in that shall be paid separately. But the reinforcement in the brickwork shall be included in the rate of the brick masonry.
- 6.11.4 Care shall be taken to see that the wall is not disturbed till it is fully set. All scaffolding, shuttering and form work for RCC work connected to the newly built wall shall be constructed with utmost care, so that the stability of the wall is fully secured. While making the shuttering for the RCC runner, nailing planks to the wall shall not be permitted. While making the shuttering for the curing the water is to be sprinkled by hose to the wall and not by throwing and splashing across the wall.

6.12 MEASUREMENT AND PAYMENT

- 6.12.1 For walls less than one brick thick the quoted rate shall be per sqm of brick masonry in place, for the thickness being specified. For brick work one brick

thick and above and mass brick masonry work, the quoted rate shall be based on actual quantities in cum at site, limited however by the drawing and as directed by the Engineer-in-charge.

6.12.2 The quoted rate shall cover the supply of all materials, labour, tools tackle plant and equipment, scaffolding and temporary works and all other incidental work required to complete the work in accordance with the above specifications. No deductions shall be made for openings less than 0.1 sqm in area and for fixtures up to 0.10 sqm in cross-section.

6.12.3 For half brick walls the rate quoted should include the cost of reinforcement as specified in clause.

6.13 LIME PUNNING

6.13.1 Mortar : The mortar for punning shall consist of one lime putty and one fine sand unless otherwise described in the item.

6.13.2 Application: The surface of the under coat on which the punning is to be done shall be left rough. The punning shall be applied, when the under coat is still green. The mortar for punning shall be applied in a uniform layer slightly more than 3mm thick between gauged pads, with which to ensure an even and uniformly thick surface by frequent checking with a wooden straight edge. It shall be finished to even and smooth surface with trowel.

All corners, arises, angles and junctions shall be truly vertical and horizontal as the case may be and shall be carefully and neatly finished. Rounding or chamfering corners, arises, junction etc., where required, shall be punned without any extra payments, such rounding, chamfering or grooving shall be carried out with proper templates or battens to the sizes required.

No portion of the surface shall be left out initially to be patched up latter on.

6.13.3 Thickness: The thickness of the finished punning shall not be less than 3mm thick.

6.13.4 Curing: Curing shall be started as soon as the punning has sufficiently hardened not be damaged when watered and in any case not earlier than 24 hours after the punning has been completed. Punning shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damages at the contractor's expenses by such means as the engineer-in-charge may approve.

6.14 HOLLOW AND SOLID CONCRETE BLOCK MASONRY

6.14.1 General :

Applicable provisions of conditions of contract shall govern the work under this section.

- a) This section covers the requirements for Hollow & Solid Masonry work in walls and partitions.
- b) Hollow and solid blocks shall conform to IS:2185. The provisions of the following Indian Standard Specifications shall form a part of this specification to the extent they have been referred to or are applicable with this Specification.

IS:269 'Specification for ordinary, rapid hardening low heat Portland Cement'.

IS:2116 'Specification for sand for masonry mortar'.

IS:1077 'Specification for common burnt clay building Bricks'.

IS:3466 'Specification for masonry cement'.

IS:2250 'Code of Practice for preparation and use of Masonry Mortars'.

6.14.2 Work included:

The Contractor shall furnish labour, materials, tools and plants so as to complete the work indicated or specified herein or both.

6.14.3 Materials

6.14.3.1 Hollow and solid concrete blocks –

Shall conform to the requirements of IS:2185. Specification for hollow and solid concrete blocks except with regard to the mix of cement concrete and sizes of aggregates which shall be as indicated. Hollow blocks shall be sound, free from cracks, broken edges, honey combing and other defects that would interfere with the proper placing of block or impair the strength or performance of construction.

6.14.3.2 Dimensions and tolerances :

6.14.3.2.1 Concrete masonry building units shall be made in sizes and shapes to fit different construction needs. They include stretcher, corner, double corner or pier, jamb, header, bull nose, and partition block, and concrete floor units.

6.14.3.2.2 Concrete block-hollow (open or closed cavity) or solid shall be referred to by its nominal dimensions.

The nominal dimensions of concrete block shall be, as follows :

Length	:	400, 500 or 600 mm
Height	:	200 or 100 mm
Width	:	50,75, 100, 150, 200, 250 or 300 mm.

In addition, block shall be manufactured in half lengths of 200, 250 and 300 mm to correspond to the full lengths.

The maximum variation in the length of the units shall be not more than ± 5 mm and maximum variation in height and width of unit, not more than ± 3 mm.

6.14.4 Classification :

6.14.4.1 Hollow (open and closed cavity) concrete blocks.

The hollow (open and closed cavity) concrete blocks shall conform to the following three grades :

- a) Grade 'A' - These are used as load bearing units and shall have a minimum block-density of 1500 kg/m³. These shall be manufactured for minimum average compressive strengths of 3.5, 4.5, 5.5 and 7.0 N/mm² respectively at 28 days (See Table 5).
- b) Grade 'B' - These are also used as load bearing units and shall have a block density less than 1500 kg/m³ but not less than 1000 kg/m³. These shall be manufactured for minimum average compressive strengths of 2.0, 3.0 and 5.0 N/mm² respectively at 28 days. (See Table 5).
- c) Grade 'C' – These are used as non-load bearing units and shall have a block density less than 1500 kg/m³ but not less than 1000 kg/m³. These shall be manufactured for minimum average compressive strength of 1.5 N/mm² at 28 days (see Table 5).
- d) Grade 'D' – The solid concrete blocks are used as load bearing units and shall have a block density not less than 1800 kg/m³. These shall be manufactured for minimum average compressive strengths of 4.0 and 5.0 N/mm² respectively (see Table 5).

6.14.5 Physical requirements :

6.14.5.1 Compressive strength – The average crushing strength of eight blocks, when determined in accordance with IS : 2185 shall not less than as specified in table 1:

Type	Grade	Density of block Kg/mm ³	Minimum Average compressive strength of units	Minimum strength of individual units N/mm ²
Hollow (open & closed cavity) load bearing unit	A (3.5)	Not less than 1500	3.5	2.8
	A(4.5)		4.5	3.6
	A(5.5)	Not less than 1500 but not less than 1000	5.5	4.4
	A(7.0)		7.0	5.6
	B(2.0)		2.0	1.6
	B(3.0)		3.0	2.4
	B(5.0)		5.0	4.0
Hollow (open and closed cavity) non-load bearing units	C(1.5)	Less than 1500 but not less than 1000	1.5	1.2
Solid load	D(5.0)	Not less than 1800	5.0	4.0
Bearing Units	D(4.0)		4.0	3.2

Table 1

6.14.5.2 Drying shrinkage – The drying shrinkage of the blocks (average of three blocks), when unrestrained, shall be determined in accordance with IS:2185 and shall not be exceed 0.1 per cent.

6.14.5.3 Moisture movement – The moisture movement (average of three blocks), when determined as described in IS:2185 shall not exceed 0.09 percent.

6.14.5.4 Water absorption – The water absorption (average of three blocks), when determined in the manner described in IS:2185 shall be not more than 10 per cent by mass.

6.14.5.5 Face shells and webs shall increase in thickness from the bottom to the top of the unit. Depending upon the core moulds used, the face shells and webs shall be flared and tapered or straight tapered, the former providing a wider surface for mortar. The thickness of the face shell and web shell be not less than the values given in Table 2.

Nominal block length width	Face shell Thickness	Thickness of Web	Total web thickness per course in any 200 mm of walling
	Min.	Min.	Min.
(1)	(2)	(3)	(4)
100 or less	25	25	25
Over 100 to 150	25	25	30
Over 150 to 200	30	25	30
Over 200	35	30	38

Table 2

Minimum face shell and web thickness

6.14.5.6 Subject to the tolerance as specified in 5.4.2.2 and 5.4.4.7, the face of masonry units shall be flat and rectangular, opposite face shall be parallel, and all arises shall be square. The bedding surfaces shall be at right angles to the faces of the blocks.

6.14.6 Blocks with special faces shall be manufactured and supplied as directed by the engineer.

6.14.7 Curing and drying - The blocks shall be cured in an immersion tank or in a curing yard and shall be kept continuously moist for at least 14 days. When the blocks are cured in an immersion tank, the water of tank shall be changed at least every four days.

After curing, the blocks shall be dried in shade before being used on the work. They shall be stacked with voids horizontal to facilitate through passage of air. The blocks shall be allowed to complete their initial shrinkage before they are laid in wall.

6.14.8 Construction of masonry - For single storeyed buildings, the hollows of blocks in foundation and basement masonry shall be filled up with sand and only the top foundation course shall be of solid blocks. But for two or more storeyed buildings, solid concrete blocks shall not be used in foundation courses, plinth, and basement walls, unless otherwise indicated. If hollow blocks are used, their hollows shall be filled up with cement concrete 1:3:6 using 12.5 mm nominal size aggregates.

6.14.9 Wetting of blocks - Blocks need not be wetted before or during laying in the walls. In case the climate conditions so require, the top and the sides of the blocks may only be slightly moistened so as to prevent absorption of water from the mortar and ensure the development of the required bond with the mortar.

6.14.10 Laying - Blocks shall be laid in mortar, as indicated and thoroughly bedded in mortar, spread over the entire top surface of the previous course of blocks to a uniform layer of not less than 10 mm and not more than 12 mm in thickness.

All courses shall be laid truly horizontal and all vertical joints made truly vertical. Blocks shall break joints with those above and below for not less than quarter of their length. Precast half length closers (and not cut from full size blocks) shall be used. For battered faces, bedding shall be at right angles to the face unless otherwise directed. Care shall be taken during construction to see that edges of blocks are not damaged.

6.14.11 Provisions for door and window frames - A course of solid concrete block masonry shall be provided under door and window openings (or a 10 cm thick precast concrete sill block under windows). The solid course shall extend for at least 20 cm beyond the opening on either side. For jambs of very large doors and windows either solid units are used, or the hollows shall be filled in with concrete of mix 1:3:6 using 12.5 mm nominal size aggregates.

6.14.12 Provisions for roof - The course immediately below the roof slab shall be built with solid blocks. The top of the roof course shall be built with solid blocks. The top of the roof course shall be finished smooth with a layer of cement and coarse sand mortar 1:3, 10 mm thick and covered with a thick coat of white wash or crude oil, to ensure free movement of slab.

6.14.13 Intersecting walls - When two wall meet or intersect and the course are to be laid up at the same time, a true masonry bond between at least 50% of the units at the intersection is necessary. When such intersecting walls are laid up separately, pockets with 20 mm maximum vertical spacing shall be left in the first wall laid. The corresponding course of the second wall shall be built into these pockets.

6.14.14 Piers - The top course of block in the pier shall be built in solid blocks. Hollow concrete block shall not be used for isolated piers, unless their hollows are specified to be filled with cement concrete.

6.14.15 Fixtures, fittings, etc. shall be built into the masonry in cement and coarse sand mortar 1:3 while laying the blocks where possible. Hold fasts shall be built into the joints of the masonry during laying.

Holes, chases, sleeves, openings, etc. of the required size and shape shall be formed in the masonry with special blocks while laying, for fixing pipes, service lines, passage of water etc. After service lines, pipes etc. are fixed, voids left, if any, shall be filled up with cement concrete 1:3:6 (1 cement : 3 coarse sand: 6 stone aggregate 20 mm nominal size) and neatly finished.

6.14.16 Finishes - Rendering shall not be done to the walls when walls are wet. Joints for plastering or pointing as specified shall be raked to a depth of 12 mm. Joints on internal faces, unless otherwise indicated, shall be raked for plastering. If the internal faces of masonry are not be plastered the joints shall be finished flush as the work proceeds or pointed flush where so indicated.

6.14.17 Block Work- Construction Practice

6.14.17.1 General :

6.14.17.1 Introduction :

Blocks are either hollow or solid. Generally they are of light weight compared to bricks. Concrete blocks to IS 2185 (Part 1) : 1979 may be used for both load bearing and non-load bearing walls. The wall thickness will vary.

For high thermal insulation, cavity walls having inner leaf of light weight concrete blocks to IS 2185 (Part 2) : 1983 may be used. Each leaf of cavity shall not be less than 100 mm.

Autoclave cellular concrete blocks to IS 2185 (Part 3) : 1984 shall not be used for foundations and for masonry below damp-proof course.

6.14.17.2 Mortar :-

6.14.17.2.1 Hollow concrete blocks :

Hollow concrete blocks shall be embedded with a mortar which is relatively weaker than the mix used for making blocks in order to avoid formation of cracks. A rich or strong mortar tends to make a wall too rigid thus localizing the effects of movements due to temperature and moisture variations, resulting in cracking of blocks. The recommended proportion of mortar measured by volume is given in Table 3

Table 3

Mix Proportion of mortar for hollow concrete blocks

Sl No Masonry	Type of work	Normal masonry (Cement: Lime: Sand)	Reinforced (Cement: Sand)
1.	Normal work	1 : 1 : 9 to 10	1 : 7 to 8
2.	Exposed to severe conditions; high intensity of loads; plasters; heavily loaded lintels and beams.	1 : 1 : 6 to 7	1 : 4 to 5
3.	Partitions of 10 cm	1 : 1 : 7 to 8	1 : 5 to 6

Note – All mortars shall have a slump of 75 mm.

6.14.17.2.2 Light weight blocks - Light weight blocks shall be embedded with a mortar mix, the strength of which is lower than mix for making blocks, to avoid formation of cracks. A 1:2:9 cement, lime, sand mortar may generally be used ; for high intensity of load it shall be 1:1:6

6.14.17.2.3 Concrete

Concrete used for filling hollow concrete block masonry when reinforced shall be 1 cement, 2 ½ sand and 3 coarse aggregate of size ranging from 4.75 mm to 10 mm. The water cement ratio shall not exceed 0.6. When cells exceed, 100 mm on the narrower side, the proportion of mix shall be 1 cement, 2 ½ sand, 3 ½ coarse aggregate for reinforced concrete and 1:3:6 plain concrete.

6.14.17.2.4 Thickness

6.14.17.2.4.1 For load bearing masonry built with hollow concrete blocks, the thickness of walls shall not be less than the values as obtained from IS 1905 : 1987.

6.14.17.2.4.2 Light weight block in load bearing masonry for external walls in framed construction shall not be less than 200 mm. However, if they are suitably braced by lateral or vertical supports, the thickness can be 100 mm. Non-load bearing hollow block walls shall be not less than 100 mm.

4.3 Autoclaved block walls in framed construction shall also be as per above; except that for load bearing work, the minimum thickness shall be 200 mm; however it can be reduced to 150 mm if properly braced.

6.14.17.3 Lateral support

Walls made of blocks shall have vertical or horizontal lateral supports at right angles to the face of the wall. Cross walls, plasters or buttress walls shall provide the lateral support.

6.14.17.4 Avoidance of crack formation

6.14C.17.4.1 General

The major in the walls or partitions in a structure constructed with blocks, whether they are of hollow or cellular types can be prevented. The preventive measures to be undertaken are covered.

6.14.17.4.2 Structural movements

Cracks may arise from alterations in length, the curvature or orientation due to load settlement, thermal expansion or changes in moisture content.

In the case of framed structures, erection of partitions and panel walls shall be delayed wherever possible until the frame has taken up, as much as possible, any deformation occurring due to structural movements.

a) Floor deformation and movement – The floor upon which a partition is built may deflect under load brought on it after the partition is built. Such deflections tend to create a non-continuous bearing for the block leading to cracks in the partition. This can be avoided by embedding wires of 3 mm diameter of mild steel or galvanized steel or welded wire mesh strip in bed joints in cement mortar 1:2 after every 900 mm to 1200 mm height.

b) Ceiling deflection and movement – A ceiling above a partition wall may deflect under loads applied after its erection or through thermal or other movements. To avoid cracking as a result of such deflection, the partition wall shall be separated from the ceiling by a gap or by a layer of resilient material or lean mortar. When this cannot be done as in the case of plastered finishes, the risk of cracking may be reduced by forming a cut between the ceiling plaster and the wall plaster.

c) Deflection or movement of structural abutments – The walls, columns or other structural elements against which the wall or partition abut, may deflect or move because of load, settlement, shrinkage or thermal effects. In order to avoid cracking of walls or partitions as a result of such movements, a slip joint shall be provided where possible, preferably packed with a resilient mortar or lean mortar.

d) Cracks in partition walls may occur at corners of door and window frames at lintel level or sill level. It may therefore be desirable to provide a nominal reinforced concrete band beam (see Fig. 1) at sill level and vertical reinforced concrete stud at either side of vertical members of frames which may in addition provide sufficient anchorage for hold fast.

6.14.17.4.3 Control of wall movements accompanying temperature and moisture changes Cracking in concrete masonry walls is often due to tensile stresses which develop when wall movements accompanying temperature and moisture change are restrained by other elements of the building or when concrete masonry places restraint on the movement of adjoining elements.

- a) There are three methods of controlling cracking in concrete masonry structures :
- 1) Specifying a limit on the moisture content of masonry units at the time of delivery and construction ;
 - 2) Incorporating steel reinforcement either in the form of nominal bond beams or horizontal joint reinforcement ; and
 - 3) Providing control joints to accommodate the movement of masonry.

In all concrete masonry construction, it is essential to employ only moisture controlled units. Their use, combined with the provision of control joints is generally adequate to prevent cracking in concrete masonry walls.

However, bond beams or joint reinforcement, or both in different locations as considered suitable may also be used in addition to the above.

Nominal bond beams shall be discontinuous at control joints, but practice here varies depending on the structural requirements. Dummy joints shall be formed when a bond beam is continuous at a control joint.

6.14.17.5 Control joints - Control joints are employed to reduce restraint by accommodating movement of masonry wall or movement of structural elements adjacent to the wall, and thus to control cracking. They are in fact vertical separations built into the wall at locations where cracking is likely due to excessive horizontal stresses. The spacing along the wall length depends upon :

- a) expected movements of the wall and other elements ;
- b) resistance of the wall to horizontal stresses ; and
- c) the extent and location in the wall of doors, windows, recesses, chases and other causes of stress concentration.

6.14.17.6 Bonded beams and studs used on structural members

6.14.17.7.1 Reinforced concrete structural bond beams may be used in concrete block masonry to meet the requirements of unusual stress conditions. Examples are as below :

- a) In buildings in earth-quake regions ;
- b) In buildings in areas where severe wind storms occur ;
- c) In buildings in areas where unfavourable soil movements and soil subsidence occur ; and
- d) In buildings where walls are subjected to excessive vibration or to heavy loads.

In all such cases, it is necessary to provide more than nominal stability for all types of masonry walls.

6.14.17.7.2 Bond beams shall be built integrally with block masonry or with special U-shaped lintel blocks slung together with reinforcing steel placed in the core of hollow of blocks filled with M15 concrete. The reinforcement shall conform to IS 456: 2000; but in no case shall be less than two 12 mm dia mild steel bars. The beams are discontinuous at control joints; but the joints should be designed to transfer forces along the wall.

6.14.17.7.3 Bond beams may be provided at any of the following locations depending on the conditions as described in 6.2.1

- a) At floor level ;
- b) At top of all door and window openings (in which case they serve as lintels over them) ;
- c) Below the sill in all window openings ; and
- d) At plinth level.

6.14.18 Preparatory work :-

Wetting of blocks :

6.14.18.1 The blocks need not be wetted before or during the laying of the blocks. In case the climatic conditions so require, the top and sides of the blocks may be slightly

moistured so as to prevent absorption of water from the mortar and ensure development of the required bond with the mortar.

6.14.18.2 Scaffolding - Scaffolding shall be on the same lines as brickwork, suitably modified where necessary.

7.0 STEEL REINFORCEMENT

7.0.1 Materials

- a. High tensile reinforcement or high yield strength deformed bars shall cover either hot rolled deformed bars conforming to IS: 1139 or cold twisted deformed bars conforming to IS: 1786.
- b. Each consignment shall be of approved make and if necessary, certificates of test performed by a recognized testing laboratory or the manufacturer shall be produced. These test certificates shall give the ultimate stress, yield stress, elongation and results of cold bend test. If further required, steel shall be tested at an approved laboratory at contractor's own cost.
- c. Reinforcing steel of different varieties and sizes and types.
- d. Reinforcement bars shall be stored at the site in such a manner as to prevent rusting and contamination of the surface by deleterious materials like dirt, oil grease, paint etc.,
- e. When placed in the work reinforcement shall be free of loose mill scale, rust, dirt, oil, grease paint etc.,
- f. Steel reinforcement shall always be protected from damages due to impact and rough handling.

7.0.2 Fabrication, Bending & Splicing

- a. Bars shall be cut to size and bent to shape in accordance with the appropriate dimensions shown in the drawings. When an overall or an internal dimension of bent bars is specified, the tolerance unless otherwise specified, shall be as in Table – XI of IS : 2502.
- b. Any excess in length supplied over the total of length of the various proportions of the bar between ends, including the specified tolerances or not shall be taken up in the end anchorages or in that portion of the bar indicated by the Architect.
- c. Bars shall be bent cold gradually by machine or any other means approved by HLL Engineer-in-charge, except in case of mild steel bars larger than 28mm. If approved by HLL Engineer-in-charge, mild steel greater than 28 mm dia. And conforming to IS: 432, only may be bent hot at cherry red heat (not exceeding 8500 C). Bars bent not shall be allowed to cool gradually in air and shall not be cooled by quenching. High yield strength deformed steel bars shall not be bent.

- d. Bars having cracks or splits shall be rejected.
- e. All bars shall be properly tagged for each identification.
- f. All reinforcement shall be furnished in full length indicated in the drawing. Splicing of bars, except those shown on the drawings, will not be permitted without the written authority of the Architect.
- g. At a tension splice, the minimum clear distance between bars shall be maintained. Splices in adjacent tension bars shall be staggered. At a compression splice each side of lapped bar may be in contact but the minimum clear spacing between the splice and an adjacent splice shall be that specified for adjacent unspliced bars.
- h. In no case shall the clear distance between two adjacent bars be less than the diameter of the bar (larger of the diameters to be considered if the adjacent bars are of different diameters) or 6mm more than the maximum size of coarse aggregate used in the concrete.
- i. Unless otherwise stated in the working drawing, provision of clause No. 2.6.4 of IS: 456 regarding cover to the reinforcement shall be followed.

7.0.3 Placing and fastening

- a. All steel reinforcement shall be accurately placed in position shown on the drawing and firmly held during the placing and setting of concrete. Bars shall be tied together with mild steel wire (annealed) not less than 0.9 mm dia. (conforming to IS : 280) or secured with clips at all intersections except where the spacing of intersection is less than 30 cms. In each direction when alternate intersections shall be tied. Binders shall tightly embrace and shall be securely held. Placing of bars on layers of fresh concrete as the work progresses shall not be permitted. Adjusting bar spacing in concrete already poured shall not be permitted after such time when the re-vibration of the surrounding concrete is no longer effective.
- b. Distance of the bars from the formwork shall be maintained by approved concrete spacer blocks, ties, hangers and other approved supports. Metal chairs that are in contact with the exterior surfaces of concrete where specially allowed should be galvanized or painted with epoxy. Layers of bars shall be supported at correct spacing by pre-cast mortar blocks or other equally suitable devices approved by the Architect. The mortar for the pre-cast blocks shall have the same composition as the concrete in which it is embedded and shall have been cured for at least 28 days before being placed in position. The use of pebbles, pieces of broken stone or bricks, metal pipe or wooden blocks will not be permitted.
- c. No reinforcement shall be bent when in position in the work without the approval. Whether or not it is partially embedded in concrete. Workmen will not be permitted to climb on bar extensions until the concrete. Workmen will not be permitted to climb on bar extensions until the concrete has sufficient strength so as not to be damaged and no movement of the bar is possible.

7.0.4 Welding & Coupling

- a. Field welding of reinforcing bars will not be permitted without the written consent of HLL Engineer-in-charge. Such approval will require identification of the type of steel used. Where welding is permitted it shall be at suitably staggered locations and at such places where the stress in steel in service does not exceed 75% of the maximum permissible stress.
- b. Procedure for welding mild steel reinforcing bars shall generally follow the requirement of IS: 2751 'Code of Practice for welding of Mild Steel Bars used for Reinforced Concrete construction'.

Welders employed for this work shall have passed the relevant qualifications tests for welders, specified in IS: 2571. Welding of bars other than hot rolled mild steel conforming to IS: 432 shall not be permitted.

- c. Whenever plans call for the use of couplers to join bars, such couplers shall have sufficient cross section to transmit the full strength of the bars. The ends of bars to be joined by coupling shall be offset for a sufficient length so that the effective cross section after cutting the screw thread shall not be less than the normal cross section of the bar. The screw thread shall be IS., metric coarse pitch conforming to SI: 1330 and relevant to the diameter to bar to be coupled.

7.0.5 Inspection

No concrete shall be deposited until the Engineer has inspected the reinforcement in place and approved the same. Concrete placed in violation of this provision will be rejected.

7.0.6 Method of Measurement & Basis of Payment

- a. The weight of reinforcement bars both plain, round and deformed incorporated in concrete and actually in place as shown in the plans or as directed by the Architect will be determined correct to one Kg as follows and this alone shall form the basis of payment.

Dia. (mm)	Weight in Kg/ mm
6	0.222
8	0.395
10	0.617
12	0.888
16	1.579
20	2.467
22	2.98
25	3.855
28	4.836
32	6.316
36	7.994
40	9.850

- b. Bolts, nuts, rivets and welds shall not be measured for payments. The rates quoted are inclusive of these and any wastage occurring during fabrication. Cost of binding wire shall be included in the quoted rate. Supporting devices, such as chairs, hangers, spacers etc., will be as directed by the Engineer-in-charge. Similarly steel used in splices and laps made at contractor's request will not be measurement for payment.
- c. The quoted price per ton of steel reinforcement in place shall cover full compensation for furnishing the materials, labour, tools and tackle, plan and equipment, supporting devices and all other incidental work required to complete the work as per specifications.
- d. Welded or coupled joints where required by HLL Engineer-in-charge, or indicated on drawings shall be counted and classified according to the diameter of bar joints and paid for at the same rate as a lap length of the relevant bar.
- e. Based on the Approved to contraction drawing showing reinforcement details, the contractor shall prepare bar bending schedules and submit the same, for the approval of HLL Engineer-in-charge. To avoid duplication of work and permit re-checking, the approved schedule shall be deemed to represent faithfully the information given on the drawing.

7.0.7 STRUCTURAL STEEL WORKS:

General:

This specification covers the supply, fabrication, transportation to site and erection on prepared foundations, structural steel work consisting of beams, columns vertical trusses, bracings shear connections etc. Fabrication, erection and approval of steel structures shall be in compliance with: These general specifications and IS:800-1962, IS:806, IS:1161 and supplementary drawings to be supplied to the contractors during execution of the work. Providing shop primer coat for steel structures. Grouting to complete satisfaction of the Engineer-in-charge/ Architects/ Consulting Engineer.

Fabrication Drawings:

The contractor shall prepare all fabrication and erection drawings on the basis of design drawings supplied to him 7 submit the same in triplicate to the engineer-in-charge for review, the Engineer-in-charge, shall review and comment, if any of the same. Such review, if any, by the Engineer-in-charge does not relieve the contractor of any of his required guarantees/ responsibilities. The contractor shall however be responsible to fabricate the structure strictly conforming to specifications and revised drawings.

Fabrication drawings shall include the following :

- member sizes and details
- types and dimensions of welds and bolts
- shapes and sizes of edge preparation for welding
- details of shop & field joints, splices including

sub-assemblies.

Bill of Materials:

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, 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 same it shall be submitted for approval. Any alternate design or in section is allowed when approved in writing by architects. However, if any variation in the scheme is found necessary later, the contractor will be supplied with revised drawings. The contractors shall incorporate these changes in his drawings at no extra cost and resubmit for review. Architects/ consultants review shall not absolve the contractor of his responsibility for the correctness of dimension, 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. The contractor shall supply three prints each of the final reviewed drawings to the architects within a week since final review, at no extra cost for reference and records. The architects will verify the correct interpretation of their requirements. If any modification is made in the design drawing during the course of execution of the job, revised design drawings will be issued to the contractor. Further changes arising out of these shall be incorporated by the contractor in the fabrication drawings already prepared at no extra cost and the revised fabrication drawings shall be duly got reviewed as per the above clauses.

Materials:

ROLLED SECTIONS:

The following grades of steel shall be used for steel structures: Structural steel will generally be of standard quality conforming to IS: 226. Whenever welded construction is specified plates of more than 200 mm thickness will generally conform to IS: 2062. Steel tubes for tubular structure shall conform to IS:1161.

WELDING MATERIALS:

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

BOLTS, NUTS AND WASHERS:

Bolts & nuts shall be as per IS : 1367 & tested as per IS : 1608. It shall have a minimum tensile strength of 44 kg/sqmm and minimum elongation of 23% on a gauge length of 5.6 mm (an original cross sectional area of the gauge length). Washers shall be as per IS: 2016. All materials shall conform to respective specifications. The use of equivalent or higher grades or alternate materials will be considered only in very special cases subject to the approval of the engineer-in-charge in writing.

RECEIPT & STORING OF MATERIALS:

Steel materials supplied by the contractor must be marked for identification and each lot should be accompanied by Manufacturers quality certificate, conforming chemical analysis and mechanical characteristics. All steel parts furnished and supplied shall be checked, sorted out, straightened & arranged by grades & qualities in stores. Structures 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 HLL Engineer-in-charge. Welding wire and electrodes shall be stored separately by qualities and lots inside a dry & enclosed room in compliance with IS:816-1968 & as per instructions given by the HLL Engineer-in-charge. Electrodes shall be perfectly dry and drawn from an electrode even, if required. 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 the design specification only with the written approval of the HLL Engineer-in-charge.

MATERIAL TESTS :-

The contractor shall be required to produce manufacturer's quality certificates for materials supplied by the contractor. Notwithstanding the manufacturer's certificates, the HLL 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 HLL Engineer-in-charge at no extra cost.

Materials for which test certificates are not available or for which test results do not tally with the relevant standards specifications, shall not be used.

FABRICATION :

Fabrication shall be accordance with IS: 800 section V and IS:806 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 drawing. The work shall also include fabricating built up sections.

Any defective material used shall be replaced by the contractor at his own expenses, 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.

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 a uniform pressure is applied.

Minor wrappings, corrugations etc. in rolled sections shall be rectified by cold working.

The sections shall be straightened by hot working where the architects so direct & shall be 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 joined by lap or fillet welding or bolting shall be even so that there is no gap between over lapping surfaces.

MARKING:

Marking of members shall be made on horizontal pads of appropriate racks or supports in order to ensure horizontal and straight placement of such members.

Marking accuracy shall be at least + or -1 mm.

CUTTING:

Members shall be cut mechanically (by saw or shear) or by oxyacetylene flame. However, all tubes for structural purposes shall be cut by saw only.

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 shall be cleaned off impurities prior to assembly.

Cutting tolerance shall be as follows:-

A) For members connected at both ends + or -1 mm.

B) Elsewhere + or -3 mm.

The edge preparation for welding of members more than 12mm 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.

DRILLING:

Bolt holes shall be drilled. Drillings shall be made to the diameter specified in drawings. No enlarging of holes filling by 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 +or -1 mm. Two perpendicular diameters of any oval hole shall not differ by any more than 1 mm.

Drilling faults in holes may be rectified by reaming holes to the next upper diameter, provided that spacing of new hole centers and distances of hole centers 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.

PREPARATION OF MEMBERS FOR WELDING:

Assembly of structural members shall be made with proper jigs and fixtures to ensure correct positioning of members (angles, nodes etc.) Sharp edges, rust of cut edges, notches, irregularities 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. All steel tubes required for fabrication shall be cut only by a hacksaw/ handsaw and shall not be gas cut except where permitted by the Engineer-in-charge. 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 into the gaps between members to be welded. Before assembly the edges to be welded as well as 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 & approved by the architects or their authorized representative before assembly. The permissible tolerance for assembly of members preparatory to welding shall be as per IS : 823-1964. After the assembly has been checked, temporary tack welding in position shall be done by electric welding keeping in view finished dimension of the structure.

WELDING PROCEDURE:-

Welding shall be carried out only by full trained and experienced welders as tested and approved by the architects. Any test carried out either by the architects 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/ Architects/ Consulting Engineer. The steel structures shall be automatically Semi-automatically or manually welded. Welding shall begin only after the checks mentioned under preparation of materials, marking, cutting, drilling & preparation of members for welding have been carried out. Welding procedures and tests for welder's skill have been conducted as per IS:823 and approved by the Engineer / Architect/ Consulting Engineer. The welder shall mark with his identification on each element welded by him. When welding is carried out on open air, steps shall be taken to protect the place of welding against wind or rain. The electrodes wire and parts being welded shall be dry. Before beginning the welding operation, each joining shall be checked to assure the parts to be welded are clean and root gaps provided as per IS : 823. For continuing the welding of seams discontinued due to some reason, the end of the discontinued seam 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 approximately 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 of the root has been cleaned by back gauging 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 & wire brushing. Packing strips shall not be allowed. The order & 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 defect in welds must be rectified according to IS: 823 & as per instruction of Engineer-in-charge/.

WELD INSPECTION:

The weld seems shall satisfy the following:

Shall correspond to design shapes & dimension. Shall not have any defects such as cracks, incomplete penetration & fusion, under cuts, rough surfaces, burns, blow holes and porosity etc. beyond permissible limits. During the welding operations and approval of finished elements, inspections & tests shall be made as shown in Annexure B. The mechanical characteristics of the welded joints shall be as in IS : 823.

PREPARATION OF MEMBERS FOR BOLTING:

The members shall be assembled for bolting with proper jigs and fixtures to sustain the assemblies without deformation & 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 assemblies, the members shall be checked and got approved by the Engineer / Architect/ Consulting Engineer. The difference in thickness of the sections that are but assembled shall not be more than 3% or maximum 0.8mm whichever is less. If the difference is larger, it shall be corrected by grinding or filling. Reaming or 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.

BOLTING UP:

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

PLANNING OF ENDS:

Planning of ends of members like column ends shall be done by grinding when so specified in the design. Planning of butt welded members shall be done after these have been assembled, the spare edges shall be removed with grinding machine or files.

The following tolerance shall be permitted on member that has been planed:

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

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 & reamed onsite after erection on

approval by the architects. For bolted steel structures, trial assembly in shop is mandatory.

The tolerance for spacing of holes shall be + or - 1 mm.

TOLERANCES:

All tolerances regarding dimensions, geometrical shapes & sections of steel structures shall be as per annexure 'C' if not specified in the drawing.

MARKING FOR IDENTIFICATION:

All elements and members prior to dispatch for erection shall be shop marked. The members shall be visibly marked with a weather proof light colored 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 bundle while the crates shall be marked directly. Each bundle or crate shall be packed with members for one and same assembly in the same bundle or crate general utility members such as bolts, gussets etc. may be packed. All bill of materials showing weight, quality and dimensions of contents shall be placed in the crates. The members shall be marked with a durable paint, in 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 & acceptance. When the member is being painted, the marking area shall not be painted out bordered with white paint. The marking and job symbol shall be registered in all shop delivery documents (transportation, for erection etc.).

SHOP TEST PRE-ASSEMBLY:

For steel structures that have the same type of welding the shop test pre-assembly shall be performed on one cut 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 'holes for field joints'.

SHOP INSPECTION AND APPROVAL:

GENERAL:

The architects 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 him that the fabrication is being undertaken in accordance with drawings and specifications. Technical approval of the steel structure in the shop by the architects 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 architects. The contractor shall furnish necessary tools, gauges, instruments etc. and technical and non-technical personnel for shop tests by the architects, free of cost.

SHOP ACCEPTANCE:

The architects shall inspect and approve at the following stages

The following approval may be given in shop.

- Immediate approval of work that cannot be inspected later.

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- Partial approvals.
- Final approval.

Intermediate approval of work shall be given when a part of the work is performed 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 filed joints
- Approval of parts with planed surfaces.
- Test erection.
- Approval of members.
- Approval of markings.

Inspection & 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.

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 stores.

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).

PAINTING & DELIVERY:

PREPARATION OF PARTS FOR SHOP PAINTING:

Painting shall consist of providing one coat of red oxide zinc chromate primer to steel members before dispatch from shop. Final painting shall be done with two coats of approved brand of enamel paint of required shade prior to erection. Primer coat shall not be applied unless: Surface has been wire brushed, cleaned of dust oil, rust etc. Erection gap between members, spots that can not be painted or where moisture of other aggressive agents may penetrate have been filled with 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:

Surfaces which are in 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. Planned 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 brickwork 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 inaccessible box type sections shall be hermetically sealed by welds. If specified elsewhere in the schedule of quantities the contractor shall paint further course of red oxide after erection and placing in position of the steel structures.

PACKING, TRANSPORTATION, DELIVERY:

After final shop acceptance and marking, the items shall be packed and loaded for transportation. Packing must be adequate to protect item against warping during loading and unloading. After lifting devices shall be used for loading in order to protect item against warping. Slender projecting parts shall be braced with additional steel bars, before loading, for protecting 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 architects. 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, plates gussets 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 architects and shall be accompanied by document showing:

- Quality and quantity of structure or members.
- Position of members in the structure.

Particulars of structure.

- Identification number/job symbol.

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 corrections shall be carried out by the contractor on his own expense. Any faulty erection done by the contractor shall be made good at his own cost. Approval by the architects or their representatives at any stages 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 got approved by the architects before the steel structures start arriving from the shop. Platform shall be provided by the contractor near the erection site for preliminary erection work.

The contractor shall make the following verifications up to receipt of material at site:-

- For quality certificates regarding materials & workmanship

According to these general specifications and drawings.

- Whether parts received are complete without defects due to

Transportation loading and unloading defects, if any are well Within the admissible limit.

For the above work sufficient space must be allotted in the storage area. Steps shall be taken to prevent warping of items during unloading. The parts shall be stored according to construction symbol and markings so that these may be taken out in order of erection. The parts shall be at least 150 mm clear from round on wooden or steel locks for protection against direct contact with ground and to permit drainage of water. If the 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.

ERECTION AND TOLERANCES:

Erection in general shall be carried out as required and approved by architects. Positioning and leveling of the structure alignment & plumbing of the stanchion & fixing every member of the structure shall be in accordance with the relevant drawings and to complete satisfaction of the architects.

The following checks and inspection shall be carried out before, during and after erection.

- Damage during transportation.
- Accuracy of alignment of structure
- Erection according to drawings & specifications
- Progress and workmanship.

In case there be any deviations regarding positions of foundations or anchor bolts, which would lead to erection deviations, the architects shall be informed immediately. Minor rectifications in foundations, orientation of bolts holes etc. shall be carried out as a part of the work at no extra cost. The various parts of the steel structure shall be so erected as to ensure stability against inherent weight wind and erection stresses. The structure shall be anchored & final erection joints completed after plan & elevation positions of the structural members have been verified with corresponding drawings and approved by the architects. 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 slopping surfaces tapered washers shall be used.

FINAL ACCEPTANCE AND HANDING OVER THE STRUCTURE:

At acceptance, the contractor shall submit the following documents

- Shop and erection drawings - either in tracings or reproducible.
- 4 copies of each of the following:

Shop acceptance documents, Quality certificate for structural, plates, etc. (electrodes, welding wire, bolts, nuts, washers etc.) List of certified welders who worked on erection of structures. Acceptance & intermediate control procedure of erection operation. Approval by the architect at any stage of work does not relieve the contractor of any of his required guarantees of contract.

METHOD OF PAYMENT:

Payment for steel work shall be made on basis of admissible weight of the structure accepted, the weight being determined as described below:-

The rate for supply, fabrication & erection shall include cost of all handling & transportation to owner's store/site of work where supply & fabrication only are involved, trimming, straightening, edge preparation, preparation and getting reviewed of fabrication drawings and providing one coat of red oxide zinc chromate primer & two coats of enamel painting. In case, owner supplies materials, the rate shall include the cost of steel materials, taking delivery of the materials from owners store, all handling re-handling, loading and unloading, transport to site of work, returning of surplus materials to owner's stores etc. complete as well as the cost of all handling and transport, scaffolding, temporary supports, tools and tackles, touching up primer coat, grouting etc. The weight for payment will be assessed from the approved fabrication drawings and the respective bill of material prepared by the contractor and approved by the architects. The weight of structural materials/ plate shall be calculated wherever necessary on the basis of IS handbook. If sections are different from IS section, then manufacturers handbook shall be adopted. No allowance in weights shall be made for rolling tolerance. Sections built out of plates structural shall be paid on the actual weight incorporated except for gussets which will be paid on the weight of the smallest rectangle enclosing the shape. No deductions shall be made for skew cuts in rolled steel sections. Welds, bolts, nuts, washers etc. shall not be measured. Rates for structural steel work shall be deemed to include the same. No other payment either for temporary works connected with this contract or for any other item such as welds, shims, racing plates, etc. shall be made. Such item shall be deemed to have been allowed for in the rate quoted for steel work.

GROUTING OF POCKETS:

Grouting of pockets and under base plates will be done only after the steel work has been leveled and plumbed and the bases of stanchions are supported by steel shims. The space below the base plate and pockets shall be thoroughly cleaned. The mortar used for grouting shall not be lesser than 1:2 (1 cement: 2 sand) grade 300 in case of concrete) and shall be mixed to the minimum consistence required, it shall be poured under a suitable head and tamped until the space has been completely filled. Four detailed specifications reference shall be made to clause 14.

Tolerances allowed in the erection of plant building Without Cranes:-

The maximum tolerances for line and level of the steel work shall be + or - 3.00 mm on any part of the structure. The structure shall not be out of plumb more than 3.5mm on each 10 m section of height and got more than 7.00 mm per 30 m section. The tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

Inadequate appearance of weld may be allowed if no other defects that might diminish weld strength are present. Sectional weld shape must comply with design indications. No concave welds shall be allowed for specified convex welds, or vice versa. Tolerance for concavity or convexity of welds shall be $1 \times A$ ("A" being the height of the triangle within the section shown), but more than 0.6 mm.

8. CEMENT PLASTER FINISHES

8.0.1 SCOPE :

This specification covers cement plaster finishes to column ceilings and similar surfaces on backgrounds normally met with such as brick stone or concrete lime, cement lime and mud plasters are not included in this specification.

8.0.2 MATERIALS

- a. Cement conforming to IS 8112
- b. Sand: It shall mean a fine aggregate which shall pass through a IS sieve No. 480 (3/16" in BS) test sieve leaving a residue not more than 5%.

The sand shall be clean, strong granular and composed of hard siliceous material. It shall be free from harmful impurities such as mica, shale or similar laminated materials, salts, alkalis and organic matters.

- c. Pit sand, fresh water, river or lake sand is preferable. Sea sand is not allowed. The water used for mixing shall be clean, free from deleterious matter. Water fit for drinking is suitable. Water shall be tested and should pass the acceptance criteria as per IS 3025.

8.0.3 SCAFFOLDING

For all exposed brick / tile work, double scaffolding independent of the work having two sets of vertical supports shall be provided. The support shall be sound and strong, ties together with horizontal pieces over which scaffolding planks shall be fixed.

For all other brickwork in buildings, single scaffolding shall be permitted. In such cases the inner end of the horizontal scaffolding pole shall rest in hole provided only in the header course for the purpose. Only one header for each pole shall be left out. Such holes for scaffolding shall, however, not be allowed in pillars/ columns less than 1m in width or immediately near the skew backs of arches. The holes left in masonry works for scaffolding purposes shall be filled and made good before plastering.

8.0.4 MIXING

Cement and sand shall be mixed dry in the specified quantity. Water shall then be added to get the required consistency for the plaster.

8.0.5 PREPARATION OF SURFACE

The joints shall be raked out properly. Dust and loose mortar shall be brushed out. Efflorescence, if any, shall be removed by brushing and scarping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

8.0.6 APPLICATION OF PLASTER

8.0.6.1 **Ceiling plaster** shall be completed before commencement of wall plaster. Plastering shall be started from the top and worked down towards the floor. All putlog holes shall be properly filled in advance of the plastering as the scaffolding is being taken down. To ensure even thickness and 'a' true-surface, plaster about 15x15cms shall be first applied, horizontally and vertically at not more than 2m intervals over the entire surface to serve as gauges. The surfaces of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall then be laid on the wall, between the gauges with trowel. The mortar shall be applied in a uniform surface slightly more than the specified thickness. This shall be beaten with thin strips of bamboo about 1m long to ensure through filling of the joints and then brought to a true surface, by working a wooden straight edge reaching across the gauges, with small upward and sideways movements at a time. Finally the surface shall be finished off true with a trowel or wooden float according to a smooth or a sandy granular texture, as required. Excessive trowelling or over working the float shall be avoided. During this process, a solution of lime putty shall be applied on the surface to make the latter workable.

8.0.6.2 **All corners**, arises, angles and junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished. Rounding or chamfering corners, arises, junction etc., where required shall be done without any extra payment such rounding or chamfering shall be carried out with proper templates to sizes required.

8.0.6.3 **In suspending work** at time end of the day, the plaster shall be left, cut clean to line both horizontally and vertically. When recommencing the plastering the edge of the old work shall be scrapped clean and wetted with lime putty before the plastering work shall be closed at the end of the day on the body of wall and not nearer than 15 cm to any corners or arises. It shall not be closed on the body of features such as plasters bands and cornices nor at the corners arises. Horizontal joints in plasterwork shall not also occur on parapet tops and coping as these invariably lead to leakage.

No portion of the surface shall be left out initially to be patched up later on.

8.0.7 PLASTERING 12MM THICK

The mortar shall be dashed against the surface and shall be thoroughly worked into all joints and other surface depressions to ensure adequate bond. The plaster shall be brought to a true, smooth and even surface with float and trowel.

8.0.8 PLASTERING 22MM THICK

20mm thick plaster shall be applied in two layers first a rough layer of mortar 12mm thick shall be dashed and pressed on the surface and when the rough layer has sufficiently set, not later than 48 hours another layer 8mm thick shall be applied and pressed smooth by float and trowel.

8.0.9 CEMENT FLOATING

While the plaster is still fresh, it shall be floated with 3mm thick coat of pure cement and heavily trowelled immediately with a trowel. Cement will be uniformly sprinkled dry over the entire area to the extent, that when rubbed smooth, the whole surface is covered with neat cement coating.

8.1 FLUSH POINTING

8.1.1 SCOPE

This specification includes flush pointing of stone / brick masonry and stone / brick pitching.

8.1.2 SCAFFOLDING

For brickwork in buildings having more than two storeys, double scaffolding shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over, which the scaffolding planks shall be fixed. For brick work in buildings upto two storeys single scaffolding shall be allowed. In this case, the inner end of the horizontal scaffolding pole shall in hole provided in the header course only. Only one header for each pole shall be left out. Such holes, however, shall not be allowed in pillars under one meter in width or immediately near the skew backs of arches. The holes left in masonry work for supporting the scaffolding shall be filled and made good, before plastering.

The contractor shall be responsible for providing and maintaining sufficiency strong scaffolding, so as to withstand all loads likely to come upon it.

8.1.3 RAKING OF JOINTS

All joints shall be raked out to a depth of 75mm, 7 or 8 days after the pitching or masonry is laid. The joints shall then be cleaned with wire brush or coconut husk to remove all dust and mortar. On no account any chipping of stone/ bricks shall be permitted. The masonry shall be kept very wet for the day previous up to the time the pointing work is completed and kept damp for 14 days thereafter.

8.1.4 MIXING

Mortar shall be mixed in the specified proportions in such small quantities and will be entirely used within 30 minutes of mixing. Water shall be added to the mortar mixture to a consistency of cream. Any mortar left over after 30minutes

of mixing or fallen on the ground during the process of pointing shall not be refused.

8.1.5 APPLICATION OF MORTOR FINISHING

The mortar shall be pressed into the raked out joints, with a pointing trowel, flush. The mortar shall not spread over the corners, edges or surface of the masonry. The pointing shall then be finished with proper tool.

The superfluous mortar shall then be cut off from the edges of the lines and the surface of the masonry shall also be cleaned of all mortar. The finish shall be such that the pointing is to the exact size and shape stipulated and the edges are straight, neat and clean.

8.1.6 MEASUREMENT

Measurement shall be done as per IS 1200.

8.2.0 SAND FACED PLASTER

8.2.1 GENERAL

The preparation of the surface, programming of work, general precautions and other miscellaneous details shall be as detailed in cement plaster finishes.

Base Coat:

The base coat shall be of cement mortar as specified and shall have a minimum thickness as specified.

Final Coat:

The finishing coat shall be of cement mortar 1:4 and 6mm (1/4") thick. The mortar shall contain sand with slightly larger proportion of coarse materials and shall be approved by the Architect. After application, the surface shall be finished with wooden float to the correct plane. Then it shall be treated with wetted sponge rubber by which sand particles stand out and given an even finish as approved by the Architect. A sample over a considerable area shall be first made in consultation with the Architect and shall be got approved before starting the work. Curing shall be perfect and to be continued for at least 14 days.

8.2.2 MODE OF MEASUREMENT

Measurement shall be done as per IS 1200.

8.2.3 ROUGH CAST PLASTER

General

The specification for sand faced plaster shall also apply to rough coast plaster, subject to the following:

Base Coat:

The first coat of plaster shall be of cement mortar 1:4 mixed and applied according to the relevant provisions of IS: 1661.

The finished thickness shall be 12mm for brick masonry and concrete surfaces and 15mm for stone masonry. The plaster shall be laid by throwing the mortar by using a strong whipping action and pressing to form a good bond. The surface shall be roughened.

Second Coat:

The second coat shall be the rough cast mixture consisting of aggregate which may vary in size from 5mm to 8mm and may consist of specially graded mixture mixed with fine sand and cement. The proportion of cement to sand to aggregate shall be 1:1 ½ :3. It shall be flung upon the first coat with large trowels to form an over protective coat. The second must be applied while the first coat is still soft and plastic. The work shall generally conform to the requirements IS : 1661. The thickness of the coat shall be about 12mm.

Item to include:

Rate for this item to include relevant portion of specification for Neeru plaster. It shall also include the base coat and finishing coat of rough plaster. Measurement shall be as specified in IS: 1200.

FLOORING

9.0.0 TANDOOR STONE FLOORING

9.2.0 Stone Slabs

Stone slabs shall be hard, sound, durable and resistant to wear, unless otherwise specified, stone slabs shall be square in shape and 25 to 40mm thick. The stone slab shall be without any veins, cracks, flaws and shall have a uniform colour. A tolerance of 3mm in thickness at any point shall be permitted. The exposed surface of stone slab shall be machine polished to a smooth, even and true plane and the edges to be chiseled to half its depth, true and square to ensure uniform width of joint. The edges of stone shall be machine cut square to the required shape, if necessary. The stone slab should be of table moulded be approved colors and shades. A few approved samples of stone slabs to be used shall be deposited by the contractor in the office of the engineer-in-charge.

9.2.0 Mortar Bedding

Cement mortar shall be prepared manually or by mechanical means. The amount of water added shall be the minimum necessary to give just sufficient plasticity for laying and satisfactory bedding. Care shall be taken in preparing the mortar to ensure that there are not hard lumps that would interfere with the even bedding of the stone slab. Before spreading the mortar, the sub-floor or base shall be cleaned of all dirt, scum, loose materials and laitance if any by scrubbing with coir or steel wire mesh or by hacking if necessary, and then well wetted without forming any pools of water on the surface. Before laying the mortar, the sub-grade shall be got approved by the Engineer-in-charge. In case PCC floor, the top shall be left a little rough. All points of level for the finished paving surface shall be marked out. The mortar shall than be evenly and smoothly spread over the base by use of screed battens, only over so much area as could be covered with the slabs within half an hour. The thickness of the mortar bedding shall be given to the bed. Unless otherwise specified, the proportion of mortar bedding shall be cement mortar 1:3 (1 cement: 3 sand) 20mm thick average. Sand for mortar bedding shall be from approved source and shall conform to IS 2116 - 1965 as applicable to un-reinforced masonry work.

9.2.0 Laying, Curing, Polishing and Cleaning :

Before laying the stone slab shall be thoroughly wetter with clean water. Neat cement grout of honey like consistency shall be spread on the mortar bed over as much area as could be covered with the slabs within half an hour. The stone slabs shall be laid on the neat cement float and shall be evenly and firmly bedded to the required level and slope in the mortar bed. The stone slabs shall be laid in the approved pattern in single or two tone colours. Each stone shall be gently tapped with a wooden mallet till it is firmly and property bedded. There shall be no hollows left. If there is a hollow sound and on gentle taping of the stone slabs, such stone slabs shall be removed and resell property. The mason shall make the joints of uniform thickness and straight lines. When the bedding

and joints of the flooring have been completed set, the surface shall be machine polished to give a smooth, even and true plane to the floor and thoroughly cleaned.

9.2.0 Rates to include

Apart from other factors mentioned elsewhere in this contract, the contractor's rate quoted shall include for the following.

- i) Cleaning the base and providing and laying bedding mortar and leveling.
- ii) Providing and fixing the stone slabs in neat cement float on the bedding mortar.
- iii) Filling joints of stone slabs with neat cement slurry of required colour to match the colour of the stone slabs.
- iv) Chiseling, polishing, finishing and cleaning.
- v) All labour, materials and use of tools for carrying out the item as specified above.

9.2.0 Mode of Measurements

Measurement for flooring, stone slabs shall be in square meter as provided.

9.2.0 Dado / Lining and Skirting

- (a) The stone slabs shall be as specified above for flooring unless otherwise mentioned. The stone slabs shall be in approved lengths to match the flooring. The exposed edges of stone slabs such as dado/lining and skirting jambs soffits, sills etc., shall be machine cut and polished smooth.

9.2.0 Mortar Backing

All joints in the face work shall be raked out to a depth equal to not less than the width of the joints or as directed by the architects/ clients engineer. Concrete surface shall be property hacked. All dirt, oil or any other material that might interfere with satisfactory bond shall be removed. The surface shall be cleaned and scrubbed with fresh water and kept wet for six hours prior to applying backing mortar. The dado / lining or skirting work shall not be commenced unless the preparatory work is passed by the CLIENT /Architects/ Clients Engineers. The proportion of mortar for backing shall be 1:3 CM . Sand in mortar bedding shall be from approve sources and shall conform to IS 1542 – 1977 as applicable to internal wall and ceiling plastering and external wall plastering. The thickness of mortar backing shall not be less than 12mm and average 20mm.

9.1 KOTA FLOORING:

The slabs shall be of selected quality, hard sound, dense, homogenous in texture, free from cracks, decay, weathering & flaws and of thickness as

specified. The top exposed faces should have been roughly polished before bringing it to site. Unless otherwise specified the slabs should be cut to the required shape and size, by using proper cutting tools. All pieces should be of uniform size.

A bed of cement mortar 1:4 shall be laid and properly levelled to an average thickness of 20 mm & the surface should be kept slightly rough to form a satisfactory key for the tiles. Neat cement paste of honey like consistency shall be spread over mortar bed at the rate of 2.5 kg / sqm, over such an area so that the paste will not harden before laying tiles. Slabs shall be soaked in water for 15 minutes and allowed to dry. The slabs shall then be fixed as per approved pattern with thin coat of cement paste on back of each slab. They will be tapped with a wooden mallet till the entire slab is properly bedded in level with adjoining slabs. Joints shall not be more than 1.5 mm wide. The surplus cement grout that may have come out of the joints has to be wiped off gently and joints cleaned. The joints shall be filled up with grey or white cement with an admixture of pigments to match the shade of the slab. The flooring shall be cured for 14 days. Then it shall be polished according to IS: 1443, except that,

- 1) First polishing with course grade carborandum shall not be done.
- 2) Cement slurry with or without pigment shall not be applied before first polishing.

9.2.0 FIXING,DADO/LINING OR SKIRTING STONE SLABS

Dado/lining or skirting shall be done only after fixing stone on the floor. The stone slabs shall be thoroughly wetted in water before being used for dado/ lining or skirting work. The stone slab shall be fixed when the backing mortar is still, plastic and before it gets stiff. All the stone slabs shall be covered with an additional layer of neat cement paste and stone shall then be pressed in mortar and gently tapped against the wall with wooden mallet. The fixing shall be done from the bottom of wall upwards without any hollows in the beds or joints. Each stone slab shall be fixed as close as possible to the adjoining stone slab. Stone slab shall be jointed in neat cement slurry to match the colour of the stone. The joints shall be uniform. While fixing the stone slab in dado/lining or in skirting work, care shall be taken to see that the joints in the adjoining floor below. Matches with the joints in the dado/ lining or in skirting as the case may be or shall be staggered as directed. When specified brass clamps and pins etc., of approved size shall also be used for fixing dado/ lining.

9.2.0 Polishing

When stone slab are completely set, polishing shall be done by hand with approved type of polishing stone. A smooth and even polished surface shall be obtained to match the finished surface of the flooring.

9.2.0 Curing

The dado / lining or skirting shall kept wet for 14 days.

9.2.0 Mode of Measurement

- a. Dado / lining shall be measured in square meter as provided.
- b. The height of skirting shall be specified in the item and shall be measured in running meter.

9.3 CERAMIC FLOORING

9.3.1 Scope

This covers ceramic tile flooring and dado work.

9.3.2 Materials

The tiles shall be of approved make and quality conforming IS 777. The thickness of tile shall be 9.5 mm unless otherwise specified.

9.3.3 Preparation of Surface and Laying

Sub grade on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tile shall be with cement mortar 1:3 or as specified. The average thickness of the bedding shall be 13mm while the thickness under any portion of the tiles shall be 8 to 10mm. The tiles shall be soaked by submerging in water for at least six hours before fixing.

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

Over this mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kgs per sqm over such an area as would accommodate about twenty tiles. Tiles shall be washed clean and shall be fixed in this grout one after another each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to surf the required position.

The surface of the flooring during laying shall be frequently checked with a straight edge at least 2m long so as to obtain a true surface with the required slope.

When full size tiles cannot be fixed they shall be cut sawn to the required size and their edges rubbed smooth to ensure straight and true points. Tiles which are fixed in the floor adjoining the wall shall enter not less than 10mm under the plaster, skirting or dado. After the tiles have been laid surplus cement grout shall be cleaned off.

9.3.4 Pointing and Finishing

The joints cleaned of the cement grout with a wire brush or trowel to a depth of 5mm and all dust and loose mortar removed. Joints shall then be flush pointed

with a cement of same shade as tiles. The floor shall then be kept wet for 7 days.

After curing the surface shall be washed and finished clean.

The finished floor should not sound hollow then tapped with a wooden mallet.

9.3.5 Measurement

Ceramic tile flooring shall be measured in sqm. Length and breadth shall be measured correct to a cm between the faces of skirting or dado where the junction of flooring with skirting or dado is square. Where coves are used at the junctions, the length and breadth shall be measured between the lower the same room.

Treads of steps over 30cm depth when paved with a glazed tiles shall be measured as flooring only without any extra riser. Extra on account of raiser shall however be paid for areas of treads whose depth does not exceed 30 cm.

9.4 GLAZED TILES IN DADO

9.4.1 The tiles shall be approved make and shall generally conform to IS: 1777. The tiles shall be of earthenware covered by a glaze thoroughly matured and fitted to the body. The tiles shall be sound, true to shape, flat and free from flaws and other manufacturing defects affecting their utility.

9.4.2 The top surface of the tiles shall not have glaze on more than 5% of the area that the tile may adhere properly to the base. The edges of the tiles shall be free from glaze, however any glaze if unavoidable shall be permissible on only up to 50 per of the surface area of edges.

9.4.3 The glaze shall be free from welts, chips, craze, specks, crawling or other imperfections from the appearance when viewed from a distance of one meter. The glaze shall be either glossy or matt as specified. The glaze shall be white in colour except in the case of coloured tiles when colours shall be specified by the Engineer-in-charge. There may be more than one colour on a tile.

(a) Dimensional and Tolerances

Glazed earthenware tiles shall be made square or rectangular in size such as 149x149mm and 99x99mm or 99x199 or as specified and shall be straight or cushion edge type.

Half tiles use as full tiles shall have dimensions which shall be such as to make the half tiles when dimensions of full tiles. Tiles may be manufactured in sizes other than those specified above.

Note: Commonly manufactured sizes include 108x108mm, 152x152mm, 200x200mm, 200x150mm and 200x100mm.

The dimensions of fittings associated with the glazed tiles namely cove base, round edge tile, angle corner cups, ridge and legs, cornices and capping beads shall be of the thickness shall be the same as the thickness of tiles given above.

(b) Tolerance

Facial Dimensions – The lengths of all the four sides of the tile shall be measured to the nearest 01mm. The average value of length / breadth shall not vary more than $\pm 0.8\text{mm}$ from the above specified dimension.

The variation of individual dimensions from average value of length / breadth shall not exceed $\pm 0.5\text{mm}$ tolerance on thickness shall be $\pm 0.4\text{mm}$.

10.0 JOINERY.

SPECIFICATIONS FOR DOOR, WINDOW AND VENTILATOR FRAMES

10.0.1 Timber for door frames shall be as specified. Timber shall be sawn in the direction of the grains. All members of a frame shall be of the same species of timber and shall be straight without warp or blow. Frames shall have smooth, well-planned (wrought) surfaces except the surfaces touching the walls, lintels, sill etc., which may be left clean sawn. Rebates, rounding or moulding shall be done before the members are jointed into frames. The depth of the rebate for housing the shutters shall be 15 mm, and the width of the rebates shall be equal to the thickness of the shutters. A tolerance of $\pm 3\text{ mm}$ and 2 mm shall be permitted in the specified finished dimensions of timber sections in frames.

10.0.2 Joints

The frames shall have dovetail joints. The Jamb posts shall be through tenoned in to the mortise of the transoms to the full thickness of the transoms and the thickness of the tenon shall be not less than 2.5 cm. The tenons shall closely fit into the mortise without any wedging or filling. The contact surface of tenon and mortise before putting together shall be glued with polyvinyl acetate dispersion based adhesive conforming to IS 4835 or adhesive conforming the WBP or MR grade of IS 851 and pinned with 10 mm dia hard wood dowels, or bamboo pins or star shaped metal pins. The joints shall be at right angles when checked from the inside surfaces of the respective members. The joints shall be pressed in position. Each assembled door frame shall be fitted with a temporary stretcher and a temporary diagonal brace on the rebated faces.

10.0.3 Fixing of frames

The frames shall be got inspected and approved by the engineer before being pinned, oiled or otherwise treated and before fixing in position. The surface of

the frames abutting masonry or concrete and the portions of the frames embedded in floors shall be given a coating of coal tar. Frames shall be fixed to the abutting masonry or concrete with hold fasts or metallic fasteners as specified. After fixing, the jamb posts of the frames shall be plugged suitably and finished neat. Vertical members of the door frames shall be embedded in the floor for the full thickness of the floor finish and shall be warping during construction. A minimum of three hold fasts shall be fixed on each side of door and window frames one at centre point and other two at 30 cm from the top and bottom of the frames. In case of window and ventilator frames of less than 1 m in height two hold fasts shall be fixed on each side at quarter point of the frames. Hold fasts and metallic fasteners shall be measured and paid for separately.

10.0.4 Measurements

Wood work wrought, framed and fixed shall be measured for finished dimension without any allowance for the wastage or for dimensions beyond specified dimension without any allowance for the wastage or for dimension beyond specified dimensions. However, in case of members having mouldings, roundings or rebates and members of circular or varying sections, finished dimensions shall be taken as the sides of the smallest square or rectangle from which such a section can be cut. Length of each member shall be measured over all to the nearest cm so as to include projection for tenons. Width and thickness shall be measured to the nearest mm and the quantity shall be worked out in unit of 10 cubic decimetre in whole numbers.

10.0.5 Rate

The rate shall include the cost of material and labour involved in all the operations described above except the hold fasts or metallic fasteners which will be paid for separately.

10.1.0 FLUSH DOOR SHUTTERS

10.1.1 Flush door shutters shall have a solid core and may be of the decorative or non-decorative (Paintable type as per IS 2202 - 1991 (Part I). Nominal thickness of shutters may be 25,30,or 35mm. Thickness and type of shutters shall be as specified.

All four edges of the shutters shall be square. The shutter shall be free from twist or warp in its plane. The moisture content in timbers used in the manufacture of flush door shutters shall be not more than 12 per cent when tested according to IS 1708 - 1986.

10.1.2 Core

The core of the flush door shutters shall be a block board having wooden strips held in a frame constructed of stiles and rails. Each stile and rail shall be a single piece without any joint. The width of the stiles and rails shall not be less than 75 mm and not more than 100 mm. The width of each wooden strip shall not exceed 25 mm. Stiles, rails and wooden strips forming the core of a shutter shall be of equal and uniform thickness. Wooden strips shall be parallel to the stiles.

End joints of the pieces of wooden strips of small lengths shall be staggered. In a shutter, stiles and rails shall be of one species of timber. Wooden strips shall also be one species only but it may or may not be same species as that of the stiles and rails.

10.1.3 Face panel

The face panel shall be formed by gluing, by the hot-press process on both faces of the core, either plywood or cross-bands and face veneers. The thickness of the cross bands as such or in the plywood shall be between 1.0 mm and 3.0 mm. The thickness of the face veneers as such or in the plywood shall be between 0.5 mm and 1.5mm for commercial veneers and between 0.5 mm and 1.0 mm for decorative veneers. The direction of the veneers adjacent to the core shall be at right angles to the direction of the wooden strips. Finished faces shall be sanded to smooth and even texture.

10.1.4 Lipping

Lipping, where specified, shall be provided internally on all edges of the shutters. Lipping shall be done with battens of first class hardwood or as specified of depth not less than 25 mm. For double leaf shutters, depth of the lipping at meeting of stiles shall be not less than 35 mm. Joints shall not be permitted in the lipping.

10.1.5 Rebating

Rebating shall be as specified.

10.1.6 Opening for glazing

Where specified the opening for glazing shall be 25 cm in height and 20 cm in width unless directed otherwise. The bottom of the opening shall be at a height of 140 cm from the bottom of the shutter. Opening for glazing shall be lipped internally with wooden batten of width not less than 25 mm. Opening for glazing shall be provided where specified or shown in the drawing.

10.1.7 Venetian opening

Where specified the height of the venetian opening shall be 30 cm from the top of the bottom rail unless directed otherwise. The width of the opening shall be as directed but shall provide for a clear space of 75 mm between the edge of the door and venetian opening but in no case the opening shall extend beyond the stiles of the shutter. The top edge of the opening shall be lipped internally with wooden battens of width not less than 25 mm. Venetian opening shall be provided where specified or as shown in the drawing.

10.1.8 Tolerance

Tolerance on width and height shall be + 3 mm and tolerance on nominal thickness shall be +/- 1.2 mm. The thickness of the door shutter shall be uniform throughout with a permissible variation of not more than 0.8 mm when measured at any two points.

10.1.9 Adhesive

Adhesive used for bonding various components of flush door shutters namely, core, core frame, lipping, cross-bands, face veneers, plywood etc. and for bonding plywood shall conform to BWP type, phenol formaldehyde synthetic resin adhesive conforming to IS 848.

10.1.10 Tests

Samples of flush door shutters shall be subjected to the following tests -

- a) End Immersion Test
- b) Knife Test
- c) Glue Adhesion Test

One end of each sample shutter shall be tested for End Immersion Test. Two specimens of 150 x 150 mm size shall be cut from the two corners at the other end of each sample shutter for carrying out Glue Adhesion Test. Knife Test shall be done on the remaining portion of each sample shutter.

10.1.11 Sample size

Shutters of decorative and non-decorative type from each manufacturer, irrespective of their thickness, shall be grouped separately and each group shall constitute a lot. The number of shutters (sample size) to be selected at random from each lot for testing shall be as specified in Table 8. If the total number of shutters of each type in a work (and not the lot) is less than twenty five, testing may be done at the direction of the engineer and in such cases extra payment shall be made for the sample shutter provided the sample does not fail in any of the test specified.

Table 8

Lot Size	Sample Size
Upto 50	1
50 – 150	2
151 – 300	3
301 – 500	4
501 and above	5

10.1.12 Criteria for conformity

All the samples shutters when tested shall satisfy the IS requirements of the tests. If the number of sample shutters found unsatisfactory for a test is one, twice the number of samples initially tested shall be selected and tested for the test. All sample shutters so tested shall satisfy the requirement of the test. If the number of samples found unsatisfactory for a test is two or more, the entire lot shall be considered unsatisfactory.

10.1.13 Fixing of shutters

For side hung shutters of height upto 1.2 m, each leaf shall be hung on two hinges at quarter points and for shutter of height more than 1.2 m, each leaf shall be hung on three hinges one at the centre and the other two at 200 mm from the top and bottom of the shutters. Top hung and bottom hung shutters shall be hung on two hinges fixed at quarter points of top rail or bottom rail. Centre hung shutter shall be suspended on a suitable pivot in the centre of the frame. Size and type of hinges and pivots be as specified. Flap of hinges shall

be neatly counter sunk into the recesses cut to the exact dimensions of flap. Screws for fixing the hinges shall be screwed in with screwdriver and not hammered in. Unless otherwise specified, shutters of height more than 1.2 m shall be hung on butt hinges of size 100 mm and for all other shutters of lesser height butt hinges of size 75 mm shall be used. For shutter of more than 40 mm thickness butt hinges of size 125 x 90 x 4 mm shall be used. Continuous (piano) hinges shall be used for fixing cup-board shutters where specified.

10.1.14 Measurements

Length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames, but excluding the gap between the shutter and the frame. Overlap of two shutters shall not be measured. All work shall be measured net as fixed and area calculated in square metres to nearest to two places of decimal. No deduction shall be made for providing ventilation opening and opening for glazing.

10.1.15 Rates

The rate includes the cost of material and labour involved in all the operations described above. Extra rate shall be payable for providing rebates in double leaf shutters.

11.0. ALUMINIUM DOORS AND WINDOWS

11.0.1 MATERIALS

The materials shall be extruding aluminum alloy conforming to IS 738.

The glass used shall be plain sheet glass or otherwise as specified and of the thickness as specified. The glass shall be free from belmishes such as waves bubbles etc.

The hardware used i.e. screw, rivets etc., shall be brass CP/ Aluminium or any other rust proof metal as specified.

11.0.2 CONSTRUCTION

The overall dimensions of windows / door units shall not differ from those given in drawings by more than 3mm. In double shutter doors as four level lock shall be provided in active leaf. Inactive leaf shall be filled with a concealed about bolt as top.

In case of double swing doors, heavy duty floor spring of approved make shall be used for both shutters.

Side hung doors shall be fitted with minimum of 2 hinges per leaf up to 2.2m height.

Side hung doors shall be provided with a minimum of hinges per leaf up to 1.2 m height.

Beading used for doors, windows, shall be screw less snap on type.

Direct contact of metal and glass shall be provided neoprene. PVC gasket for beading. Shutter sections of casement windows shall have provision for fixing double weather strips.

11.0.3 Measurements

The doors / window units shall be measurement in square meters or lump sum on unit basis as specified.

12.0 PVC DOORS AND WINDOWS

The PVC doors and windows should be water proof, rot proof and weather proof, termite proof, maintenance free, perfectly designed for stability and versatility.

12.1. INSTALLATION

Survey the area where the door/window is to be installed. This is done to determine the correct dimension of the door to be manufactured.

Measure the opening for the length and the width from various places. The narrowest part of the measurement may be taken as if the dimension of the door.

Fixing of the door can be done with expandable fasteners. The expandable fasteners consist of a shank, sleeve, wedge and a nut.

A matching hole has to be made from the outer frame to the wall. The fastener is then put in the hole and tightened. On tightening the screw, the sleeve expands and provides a grip in the wall.

Fixing of the door can also be done by fixing a bracket. One end of the bracket is fixed to the door frame. The other end of the bracket is fixed to the wall where slot is provided. The slot is provided. The slot can then be covered by means of plaster.

Finally a polysulphide sealant is applied along with the periphery.

14.0. PAINTING.

14.0.1 General

Painting shall commence from the top of walls and shall be worked down. Before any painting is taken up, the surface after preparation shall be shown to the Engineer and got approved. A sample panel shall be painted and after approval only, the painting shall be commenced. The paints shall be mixed and applied in accordance with the manufacturer's instructions. The paint shall be applied with brushes including whitewash.

In case of selection of special shades and colour (not available in standard shades) the contractor shall mix different shades and prepare test panels of minimum size 1 meter square as per instruction of the Engineer and obtain his approval prior to application of finishing paints. Skilled laborers in a workman like manner shall do painting. All material shall be evenly applied, so as to be free of sags, runs crawls or other defects.

All coats shall be of proper consistency. In case of application by brush, no brush mark shall be visible. The brushes shall be clean and in good condition before application of paint.

All priming undercoats for painting shall be tinted to approximate colour of the finishing coats. Finished coats shall be of exact colour and shade as per approved samples and all finish shall be uniform in colour and texture.

For use of any specified paints the contractor shall prepare 1 meter x 1 meter panels duly painted as per finishing schedule and get the same approved by the Engineer. The procedure viz. preparation of surface, number of coats, shade etc., shall be followed while painting. Tinting agents compatible with respective tint may be permitted to get the desired shades.

14.0.2 Materials

The Contractor shall obtain all paints, materials of highest grade products of well known approved manufacturer and shall be delivered to the site in original sealed containers bearing brand name, manufacturer's name batch No., date of manufacturing and colour shade. All materials shall be subject to inspection, analysis and approval by the Engineer. It is desired that materials of one approved manufacturer only shall be used. The shade shall not vary if the bulk supply is received from the same manufacturer. In case of shade variation the entire quantity so received shall be replaced and fresh supply obtained to match the approved shade.

All paint shall be subject to analysis from random samples taken at site from painters bucket, if so desired by the Engineer.

All primer coats shall be compatible with the material of the surface to be finished as well as with the finishing coats to be applied.

All unspecified materials such as turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognized manufacturers and shall be approved by the Engineer.

14.0.3 Acrylic emulsion paint

Acrylic emulsion paint shall be water based acrylic copolymer emulsion with rutile titanium dioxide and other selected pigments and fungicide of Asian or Berger make. It shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without any deterioration in colour or without showing flaking blistering or peeling.

14.0.4 Synthetic enamel paint

Synthetic enamel paint shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard durable and glossy finish to all exterior and interior surfaces. White and pastel shades shall resist yellowing and darkening with aging. The paint shall conform to IS: 2932 and IS: 2933. Make: Asian, Berger, Johnson & Nicholaon.

14.0.5 Preparation of surfaces

Generally all surfaces to be painted shall be wire brushed, cleaned of oil grease and other foreign matters. The surfaces shall then be rubbed with emery paper and remove the dust by through washing with clean cotton cloth. Special surfaces like concrete, plaster, woodwork etc., shall be treated differently as explained below.

14.0.6 Concrete surfaces

Air water jet shall be forced through a nozzle having a tip with an orifice of 1.5cm with a pressure. If the pressure is not enough to open out air holes the pressure shall be increased and all the laitance shall be completely washed out. The surfaces shall then be allowed to dry for 48 hours. The pinholes exposed due to air water jet shall then be given a sack rub finish with cement fine sand and all excess cement shall be removed with clean cloth. Any imperfections, bulging noticed in the concrete surfaces, should be ground chipped and made good prior to sack rub finish.

14.0.7 Masonry / Plastered surfaces

The surface shall be thoroughly cleaned off mortar droppings and other sticking. All loose scales and flakes shall be removed by rubbing with dry hessian cloth or sand papering. All holes shall be filled with filling compound (approved putty) and the surface rubbed smooth to get evenness of the existing surface. Area to be distempered shall be applied with one coat of white chalk solution mixed with required quantity of glue or plaster of paris and shall be sand papered before distempering. The area to be cement painted shall be wetted by sprinkling water with a few minutes interval between each spray.

14.0.8 Steel Work

The surface shall be thoroughly cleaned sand papered and rubbed with emery cloth of necessary to remove grease, mortar or any other foreign material. The clean surface shall be shiny and free from brush marks, patches, blister and other irregularities, surface thus finished shall be got approved before painting.

14.1 Application of paints

14.1.1 General

The method of application of paints shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the contractor shall mix different shades and prepare test panels of minimum size 1 meter square as per instruction of the Engineer and obtain his approval prior or to application of finishing shades.

Proper tools and implements shall be used. Scaffoldings if used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor holes.

Painting shall be done by skilled labours in a workman like manner. All material shall be evenly applied. So as to be free of sags, runs crawls or other defects. All coats shall be of proper consistency. In case of application by brush no brush marks shall be visible. The brushes shall be clean and in good condition before application of paint.

All priming undercoats for painting shall be applied by brush only and rollers spray equipment etc. shall not be used.

No work shall be done under conditions that are unsuitable for production of good results. No painting shall be done when plastering is in progress or is drying. Application of paint, which seals the surfaces to moisture shall only be done after the moisture on and below the surface has dried out totally.

All coats shall be thoroughly dry before a succeeding coat is applied. Costs of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered properly by applying the specified number of coats, further coats shall be applied by the contractors when so desired by the Engineer.

14.1.2 Preparing surface;

The surface to be painted shall be cleaned and all holes, cracks, surface defects repaired with gypsum and allowed to set hard. All irregularities shall be made smooth by sand papering, grinding etc. The surface so prepared shall be completely free from dust before painting is commenced.

14.1.3 Priming coat:

The preparation of the surface and the application of the priming coat shall be done as recommended by the manufacturer of the paint.

14.1.4 Finishing coats:

Two coats of finishing paint of approved shade shall be applied over the priming coats. The instruction of the manufacturer shall be followed in applying the finishing coats of paints

14.1.5 Mode of Measurement:

It shall be same as given for oil bound washable distemper. The quoted rate shall include supply of all materials, labour scaffolding, plant, equipment, tools and tackles and curing of painted surfaces, all lead and lifts.

15.0 WALL PUTTY

15.0.1 General:

Water based putty shall be used for filling or smoothening out cracks and dents on the wall to provide a smooth surface for paint application. Thinning, if required shall be done using only municipal or potable water and blending to a smooth paste.

15.0.2 Application:

The surfaces shall be cleaned well and all the loose matter shall be removed (by sanding with paper and wiping off the powder with a cloth or a cotton waste. After applying a coat of primer and allowing it to dry for 8 hours. The sanding shall be done lightly with emery paper. Next wall putty shall be applied with the help of putty knife to obtain smooth and uniform surface. Care shall be taken to fill up the deep dent in thin layers. After allowing to dry for 4 hours sanding with emery paper shall be done. The loose powder shall be wiped off with a cloth or clean cotton waste.

16.1.1 SCHEDULE OF FITTINGS

- I. Fitting shall be of the materials as specified. These shall be well made reasonable, smooth and free from sharp edges, corners, flaws and other defects screw holes shall be counter-sunk to suit the head of specified wood screws. All hinge pins shall be of steel and their riveted heads shall be well formed.

Iron fittings shall be finished bright or black enameled or copper oxidized, brass fittings shall be finished bright (brass), oxidized or chromium plated (electro plated) and aluminium fittings shall be finished bright or anodized or as specified. Fittings shall be got approved by the site engineer before fixing.

- II. Unless otherwise specified, the schedule of fittings as given below shall apply for various kinds of doors and windows.
- III. Screws used for fittings shall be of the same metal and finish as the fittings. However, anodized steel screws shall be used for fixing aluminium fittings.
- IV. Fittings shall be fixed in proper position as shown in the drawings or as directed by the site engineer. These shall be truly vertical or horizontal as the case may

be screws shall be driven home with screw driver and not hammered in. Recesses shall be cut to the exact size and depth for the counter sinking of hinges.

16.2.1 Butt Hinges

These shall be mild steel butt hinges (ordinary), brass butt hinges (ordinary), brass but hinges (heavy), brass oxidized butt hinges (ordinary), brass oxidized butt hinges (heavy), aluminium hinges as specified. Where butt hinges are not specified in aspect of the type being ordinary or heavy. These shall be taken as ordinary. Brass and aluminium built hinges shall be invariably cranked MS hinges shall be cranked or uncranked though ones shall be preferred.

Brass and MS butt hinges shall conform generally to Indian Standard Specifications for butt hinges IS 205.

16.2.2 Parliament Hinges

These shall be of mild steel or cast brass as specified. These shall generally conform to Indian Standard Specifications IS 362.

The brass parliament hinges shall be finished bright brass, chromium plated or oxidized unless otherwise specified.

16.2.3 Spring Hinges

Spring Hinges shall be single action or double action as specified. With single action spring hinges. The door shutter is capable of opening on one side and with double action spring hinges. It can open on both sides.

These shall be made of iron or brass casing with steel spring as specified, and shall conform generally to Indian Standard Specifications IS 453. The iron spring hinges shall be finished stove-enameled black and brass hinges finished bright brass, chromium plated, oxidized or as specified. Hinges shall work smoothly and shall hold the door shutters truly vertical in closed positions.

16.2.4 Door Latch

This shall be of mild steel brass or as specified and shall be capable of smooth sliding action. In case of mild steel latch, it shall invariably be oxidized (copper finished) and in case of brass, it shall be finished bright (brass) oxidized or chromium plated, according to as it is specified.

Door bolts, tower and barrel type :

The following types of door bolts shall be used as specified:-

1. Mild steel tower bolts with cat iron bolts.
2. Mild steel barrel bolts with mild steel bolts.
3. Brass barrel bolts with cast barrel and rolled or drawn bolts.
4. Brass barrel bolts with barrel made from sheets and roller of clear bolts (extruded type).

5. Aluminium barrel bolts with barrel made from sheets and rolled or drawn bolts (extruded type).

Unless otherwise specified, brass barrel bolts with cast barrel and rolled or drawn bolts shall be accepted. The cast iron and mild steel bolts shall be made in one piece. The knobs of brass bolts shall be cast and the bolt fixed into the knob. The door bolts shall be finished to correct shape, so as to have a smooth action.

In case of mild steel door bolts, the plates and straps after assembly shall be firmly riveted. The rivet head shall be properly formed and the rivet back shall be flush with the plate.

Aluminium barrel bolts shall be manufactured from extruded section of barrel and bolts. Knob shall be properly screwed to the bolt and riveted at the back. In case of brass and aluminium barrel bolts. Steel spring and ball shall be provided between the bolt and the barrel.

16.2.5 Door Handles

16.2.5.1 Brass handles:

These shall be of cast brass of the specified size and of the shape and pattern as approved by the site engineer. These shall generally conform to the Indian Standard Specification for door handles IS 208 has revised. The size of the handle shall be determined by the inside grip of the handle. Door handles shall be 10cm size and window handles of 7.6 cm size. Unless otherwise specified. These shall be fixed with 2.5 cm long wood screws.

16.2.5.2 Aluminium Handles

These shall be of aluminium of the specified size and of the shape and pattern as approved by the site Engineer. The size of handle shall be determined by the inside grip of the handle. Door handles shall be of 10 cm and size and window handles of 7.6 cm size, unless otherwise specified. These shall be fixed with 2.5 cm long wood screws.

Aluminium handles shall be finished bright or anodized, according to as it is specified.

16.2.5.3 Iron handles:

These shall be mild steel sheet, pressed into oval section. These shall conform to Indian Standard Specifications for door handles IS 208. The size of the handles will be determined by the inside grip of the handle. Door handles shall be of 10 cm size and window handles of 7.6cm unless otherwise specified. These shall be fixed with 2.5 cm long wood screws.

16.2.6 Mortice Lock

Mortice lock with latch and a pair of lever handles shall have steel casing and brass bolts and shall be right or left handed as shown in drawings or as directed by the site engineer, it shall be of the best Indian Make.

The shape and pattern shall be approved by the site engineer. The size of the lock shall be determined by its length. The lock for single leaf door shall have plain face and that for double leaf door a rebated face.

Lever handles with springs shall be mounted on plates and shall weight not less than 0.48 Kg per pair. These shall be of brass finished bright (brass) chromium plated or oxidized according to as it is specified.

16.2.7 Mortice Latch

Mortice latch, with one head bolt and a pair of lever handles shall have a steel casing and brass bolt and shall be right or left handed as shown in drawing or as directed by the site engineer. It shall be of the best Indian make. The shape and pattern shall be approved by the site engineer. The size of the mortice latch shall be determined by its length. The latch for single lead door shall have plain face and that a double leaf a rebated face.

The lever handle with springs shall be mounted on plates and shall not weight less than 0.48% kg per pair. These shall be of brass, finished bright (brass) chromium plated or oxidized according to as it is specified.

16.2.8 Hooks and Eyes

Hooks and eyes shall be of mild steel or hard drawn bass as specified. These shall generally conform to the Indian Standard Specifications for gates and shutter hooks and eyes given in IS 20. The size of the hooks and eyes shall be determined by the length of the hook measured out to out.

17.0 GRANITE SLAB WORKS

17.0.1 General

Granite stone slab shall be of uniform thickness as specified and shall be of uniform texture and colour free of veins and streaks. The colour shall be as specified, variation or thickness shall not exceed 12mm. The edges shall be in line, shape and size as specified.

The edges and exposed surface shall be rough dressed / one line dressed / two line dressed/ three line dressed / palmate dressed / mirror polished as specified.

- a. Rough Dressing :
The stone surface shall be chisel dressed to one plan by removing all projections and brushings so that the maximum depression does not exceed 6mm.
- b. One line dressing :
Same as in 17.1.1.above but with maximum depression limited to 4m.

- c. Two line dressing :
Same as in (a) and (b) above, but variation or depressions not to exceed 2.5mm.
- d. Three line dressing :
Further chiseling to be done as to limit the depressions to 1.5mm.
- e. Fine chisel dressing or plamana dressing :
After three lines dressing, the surface is further smoothened by using a special palmane tool so that the maximum variation in evenness does not exceed 1.0mm.
- f. Mirror Polishing

The surface shall be hand or machine polished as specified to achieve a perfectly plane and even surface. The polished surface shall reflect light like a mirror.

17.0.2 Fixing

The slab shall be fixed to a backing of mortar 1:6 or as specified in such sizes and to the pattern as directed by the Architect. The slabs shall be secured by means of stainless steel or such other anchors as may be specified, one end being grouted into a hole drilled into the side (width) of the slab and the other grouted into the masonry wall. The grouting shall be done with epoxy or such other grout as may be specified. Anchors shall be used at the rate of One No.1 per 0.40 sqm. All joints shall be of thickness as specified and shall be pointed if so required.

18.0 WATER BOUND MACADAM ROADS

18.0.1 Scope

This work shall consist of clean, crushed aggregate mechanically interlocked by rolling and bonded together with screening, binding, material where and water laid on a prepared sub-grade, sub-base, base or existing pavement as the case may be and finished in accordance with the requirements of these specifications and in close conformity with the lines, grades, cross-sections and thickness as per approved plans or as directed by the Engineer-in-charge.

18.1 Materials

18.1.1 Coarse aggregate – general specifications :

Coarse aggregates shall be either crushed or broken stone, crushed slag, over burnt brick aggregates or any other naturally occurring aggregates such as kankar, laterites of suitable (which shall be used in sub-base courses only). The aggregates shall conform to the physical requirements set forth in table. The type and size range of the aggregate shall be specified in the contract or shall be specified by the Engineer-in-charge.

PHYSICAL REQUIREMENTS OF COURSE AGGREGATE

Test	Test Method	Requirement
Los Angles Abrasion Value	IS: 2386 (Part IV)	50% (Maximum)
Aggregate impact value	IS: 2386 (Part IV) or IS 5640	40% (Maximum)
Flakiness Index	IS : 2386 (Part I)	15% (Maximum)

- (*) Aggregate may satisfy requirements of either of the two tests.
- (**) Aggregates like brick metal, kankar, laterite etc., which get softened in presence of water shall be tested for impact value under wet conditions in accordance with IS : 5640.
- (***) The requirement of flakiness index shall be enforced only in the case of crushed broken stone and crushed slag.

18.1.2 Crushed or broken stone shall be hard, durable and generally free from excess flat, elongated, soft and disintegrated particles and other deleterious material.

18.1.3 Crushed slag shall be made from air-cooled blast furnace slag. It shall be of angular shape reasonably uniform in equality and density and generally free from any thing elongated and soft pieces, dirt or other deleterious matter. Crushed slag shall not weigh less than 1120 kg per cum and the percentage of glossy material in it shall not be in excess of 20 lt. should also comply with the following requirements.

- (i) Chemical stability : To comply with requirements of appendix BS 1047
- (ii) Sulphur content : Maximum 2 percent
- (iii) Water absorption : Maximum 10 percent

18.1.4 Brick metal shall be made out of over burnt bricks bats and be free from dust and other objectionable and deleterious materials.

18.1.5 The coarse aggregate shall conform to one of the grading given in table as specified, provided, however, the use of grading no. 1 shall be restricted to sub-base course only.

GRADING REQUIREMENTS FOR COARSE AGGREGATE

Grading No.	Size Range	Sieve Designation	Percent weight passing by
1	90mm to 45mm	125 mm 90 mm 63 mm 45 mm 22.4mm	100 90-100 25-60 0-15 0-5
2	63mm to 45mm	90 mm 63 mm 53 mm	100 90-100 25-75

		45 mm 22.4 mm	0 -15 0 -5
3	53mm to 22.4 mm	63 mm 53 mm 45 mm 22.4 mm 11.2 mm	100 95-100 65-90 0-10 0-5

Note: The compacted thickness for a layer with grade 1 shall be 100mm while for layer with other grades i.e., 2 & 3, it shall be 75mm.

18.2 Screening

Screenings to fill voids in the coarse aggregates shall generally consist of the same material as the coarse aggregate. However, where permitted predominantly non-plastic materials such as moorum or gravel (Other than river borne material) may be utilised for this purpose provided that the liquid limit and plasticity index of such material is below 20 and 6 respectively and the fraction passing 75 micron sieve does not exceed 10 percent.

Screening shall conform to the grading set forth in the table. The consolidated details of quantity of screening required for various grades of stone aggregate are given in the table. The table also given the quantities of materials (loose) required for 10 sqm for sub-base / base compacted thickness 0 75/100mm.

The use of screenings shall be omitted in the case of soft aggregate such as brick metal, kankar, laterite, etc as they are likely to get crushed to a certain extent under rollers.

GRADING SCREENINGS

Grading classification	Size of Screening	Sieve Designation	Percent by Wt. Passing the sieve
A	13.2mm	13.2mm 11.2mm 5.6mm 180 micron	100 95-100 15-35 0-10
B	11.2mm	11.2mm 5.6mm 180 micron	100 90-100 15-35

18.3 Binding material

Binding material to prevent raveling of water bound macadam shall consist of a fine grained material possessing PI value less than 6 as determined in accordance with IS 2720 (Part V).

The quantity of binding material where it is to be used will depend on the type of screenings. Generally, the quantity required for 75mm compacted thickness of water bound macadam will be 0.06-0.09 cum /10sqm and 0.08-0.10 cum / 10 sqm for 100mm compacted thickness.

19.0 CONSTRUCTION PROCEDURE

19.0.1 Preparation of foundation for receiving the WBM course

The sub-grade, sub-base or base or receive the water bound macadam course shall be prepared to the specified lines and cross fall (camber) and cleaned of all dust, dirt and other extraneous matter. Any ruts or soft yielding places that have appeared due to improper drainage, service under traffic or other reasons shall be corrected and rolled until firm.

19.0.2 Inverted choke

If WBM is to be laid directly over the sub-grade, without any intervening pavement course, a 25mm coarse or screening (Grade B) or coarse sand shall be spread on the prepared sub-grade before application of the coarse aggregate is taken up. In case of fine sand or silty or clayey sub-grade, it is advisable to lay 100mm insulating layer of screening or coarse sand on top of fine grained sand, the gradation of which will depend upon whether it is intended to act as a drainage layer as well.

19.0.3 Spreading coarse aggregate

The coarse aggregates shall be spread uniformly and evenly upon the prepared base in required quantities from stockpiles along the side of the road or directly from vehicles. In no case shall these be dumped in heaps directly on the area where there are to be laid not shall their hauling over a partly completed base be permitted. The aggregates shall be spread to proper profile by using templates placed across the road about 6m apart. Where possible, approved mechanical devices shall be used to spread the aggregates uniformly so as to minimize the need of their manual rectification afterwards.

The thickness of consolidated WBM shall be 150mm laid in two layers of 75 mm compacted thicknesses each. No segregation of large or fine particles shall be allowed, the coarse aggregate, as spread shall be of uniform gradation with no pockets of fine material.

The coarse aggregates shall normally not be spread more than three days in advance of the subsequent construction operation.

19.0.4 Rolling

After the laying of coarse aggregate, these shall be compacted to full width by rolling with either three-wheeled power roller to 8 to 10 ton capacity or an equivalent vibratory roller. The weight of the roller shall depend on the type of the coarse aggregates.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edges/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to

the center line of the road, in successive passes uniformly lapping preceding tracks by at least one half width.

Rolling shall be discontinued when the aggregates are partially compacted with sufficient void space in them to permit application of screenings. However, where screenings are not to be applied, as in the case of crushed aggregates like brick metal, laterite and kankar, compaction shall be continued until the aggregates are thoroughly keyed. During rolling, slight sprinkling of water may be done, if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wave like motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities corrected by loosening the surface, adding or removing necessary amount of aggregates and re-rolling until the entire surface conforms to desired cross fall (camber) and grade. In no case shall the use of screenings be permitted to make up depressions.

Material, which crushed excessively during compaction or becomes segregated shall be moved and replaced with suitable aggregates.

19.0.5 Application of screenings

After coarse aggregate has been rolled to clause No. 24.4 screenings to completely fill the interstices shall be paid applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregate. The screenings shall not be dumped in piles but be spread uniformly in successive thin layer either by the spreading motions of hand shovels or by mechanical spreaders or directly from tipper with suitable grid spreading arrangement. Tipper operating for spreading the screenings shall be so driven as not to disturb the coarse aggregate.

The screenings shall be applied at a slow and uniform rate (in three more application) so as to ensure filling of all voids. This shall be accompanied by dry rolling and booming with mechanical brooms, hand-brooms or both. In no case shall the screenings be applied as fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue no more screenings can be forced into the voids of the coarse aggregate.

19.0.6 Sprinkling of water and grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operation shall be continued, with additional screenings applied as necessary until the coarse aggregate has been thoroughly keyed, well bonded

and firmly set in its full depth and a grout has been formed of screening. Care shall be taken to see that the base or sub-grade does not get damaged due to the addition of excessive quantities of water during construction.

19.0.7 Application of binding material

After the application of screenings in accordance with clause 24.5 and 24.6, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water the resulting slurry swept in with hand brooms or mechanical brooms to fill the voids properly and rolled during which water shall be applied to the wheels of the rollers if necessary, to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids, forms a wave ahead of the wheels of the moving roller.

19.0.8 Setting and drying

After the final compaction of water bound macadam course, the payment shall be allowed to dry overnight next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed in the road until the macadam has set. The Engineer shall have the discretion to stop hauling traffic from using the completed water bound macadam course, if in his opinion it would cause excessive damage to the surface.

The compacted water bound macadam course should be allowed to completely dry and set before the next pavement course is laid over it.

19.0.9 Surface finish and quality control of work

The surface finish of construction shall conform to the requirements of clause 902. Control on the quality of materials and works shall be exercised by the Engineer and accordance with section 900. The water bound macadam work shall not be carried out when the atmospheric temperature is less than zero degree c in the shade.

19.0.10 Measurement

Water bound macadam shall be measured as finished work in cubic meters.

20.0.1 STRUCTURAL GLAZING SEMI UNITIZED

The scope includes Providing, fabricating and fixing Semi Unitized Structural Glazing system using suitable extruded aluminium sections for frames anodized to approved colour of 20 microns. Extruded section to be of aluminium alloy as per ISI 6062 (T5 or T6 with temper) confirming to ASTM B221 or approved equivalent standard. The framework should have water tight joints and designed for Pressure Equalised system with provision for rainwater drainage. MS brackets (hot dip Galvanised) or extruded aluminium section brackets to be fixed

to building structure with 10mm dia anchor fasteners. The main aluminium frame to be fixed to bracket with suitable SS bolt/nut washer. The complete framework to be aligned and leveled as required.

20.0.2 SEALANT –

The reflective glass units are to be glued to separate glass panel frames (made out of suitable aluminium section) with specified/approved structural Silicone sealant of Dow Corning, G.E Silicone or of approved manufacturer. The sealant to be applied as per design and system approved by the manufacturers in writing for this project. After proper curing and testing by Sealant Manufacturer. Each panel to be fixed to main frame individually with SS fasteners. After aligning the panels to correct line/level the gaps between glass to be sealed with weather Sealant of approved make.

20.0.3 SYSTEM –

The system to be designed to take horizontal and vertical movement Upto 10mm for every floor and capable of withstanding wind pressure of 150 kpa .all as per drawing. The system design should be generic to accommodate double or single glass as maybe required and gasket based, designed with chamber for pressure equalization. Shop drawings submitted for approval shall show the full details of fire stops / smoke seal. The rate include detailed design calculations taking into consideration the wind load, seismic forces adequate factor of safety and the relevant I.S code and the International code and approved by qualified Structural Consultant. Contractor to furnish detailed working weight of the aluminium per sqmt (minimum 7.5 kg/sqmt).

The rate should include for if required openable panels (top hung) as indicated in drawing with SS heavy duty self balancing friction hinges and multi point handle cum lock. Smoke seal/fire stop around vision panels to be provided and suitably sealed. 6mm thick E-board duly painted as thermal insulation in spandrel panel to be provided. Framework to be fabricated out of SG R series as per details in enclosed drawing with Verticals and Horizontals of size 130 x 55mm suitable for floor height upto 4.1mts and horizontal spacing of 1.1mts. Main frame to be assembled as per 4.1mts and horizontal spacing of 1.1mts. Main frame to be assembled as per design required and fixed to prefixed clamps with bolt/nut and washer. The framework thus fixed to be properly aligned and leveled to required grid work. The glass frames suitably glazed as described above with glass specified is then fixed to main frame. The gaps between panels are properly sealed with weather sealant (DC 975) or EPDM weather pressure gasket to ensure no leakage and work completed as per design and specification.

- a. Aluminium frame: SG R series. Main section (Vertical & Horizontal) - 132 x 55 (2.37kg/mt) Glass Panel Section - 38 x 42 (0.73 kg/mt)
- b. Glass : 6mm thick Heat Strengthened Reflective Glass of Saint Gobain (Antileo Sky Blue or Refleclosal Green)

Note:

- 1) The manufacturer's design the size of sealant (BYTE) to be applied after carrying out the laboratory test on the materials (Glass and Aluminium) to be used for the particular project considering wind/dead loads.
- 2) The sealant is to be applied as per the design data given by the manufacturers. They carry out random field test on the sealant applied panels. The logbook is maintained for all the panels. The manufacture certify that the application is done as per their specifications. On completion of project they issue PROJECT WARRANTY.

21.0.4 HARDWARE

21.0.4.1 Clamps

Properly designed clamps (Galvanized M.S.or Aluminium Alloy) to withstand the loads and pressures will be used Holding Down Bolts shall be 10mm dia S.S. or M.S properly treated to withstand corrosive action. Stainless steel bolts to be used to fix aluminium vertical to clamps.

The clamps are designed to allow independent vertical movement of frame due to temperature variation (of building and aluminium frame) and earthquakes. Non usage of such system will result of frequent breakage of glass.

21.0.4.2 All other bolts/screws etc. shall be of properly treated materials.

21.0.4.3 All gaskets, packing shall be EPDM, Neoprene or nylon for long life.

21.0.5 WATER PROOFING:

In addition to providing drainage system in the frame, Weather Strip or Weather Sealant between two glass panels shall be applied as required. Sealant to fill gaps between frame and masonry will be applied.

21.0.6 **FIRE / SMOKING PROTECTION:** Flashing below and above the slab will be provided with proper insulation.

22.0.1 ALUMINIUM COMPOSITE PANEL

The scope includes providing and fixing of Aluminium Composite Panel using 4mm thick composite panel consisting of 3.0mm thick polythelene resin core sand witched between two skins of 0.50mm thick aluminium sheet (alloy designation 310S) tensile strength 16.67kg/cm³ making a total panel thickness of 4mm. The top skin to be painted with PVDF paint coat (Kynar 500 or equivalent) of minimum 25 micron thickness & bottom skin with protective paint coat of make Eurobond or equivalent.

The supporting framework shall be made to suit the grid requirement at site out of extruded section 38x38x3mm aluminium angle section or 50x25x2mm tube section running vertically or horizontally fixed to building structure through M.S / aluminium clamps prefixed to masonry with suitable anchor fastener or screws as required. After aligning the framework for level and lines, the ACP panel cut

to size and bent at edges to form a tray to be fixed to aluminium grid with metal screws. All hardware will be corrosion resistant. The gaps will be sealed using weather sealant like Dow Corning 789 or equivalent with necessary hardware etc - all complete

22.0.2 SKYLIGHT

The 6mm Multi wall Polycarbonate Sheets are fixed over MS Frame Work painted with two coats of anti corrosive Zynchromite Yellow Primer and one coat of approved colour enamel paint. The Sheets are fixed over the MS Structure with specially designed Aluminium Dry Glazing System of 50mm width, which is duly anodized and fitted with necessary accessories like non corrosive hardware, EPDM Rubber Gaskets, weather caps and Silicone Sealants.

23.0.1 PRE-CONSTRUCTION ANTI-TERMITE TREATMENT.

I.S.I. SPECIFICATIONS

24.0.2 CHEMICALS

The chemicals used for the soil treatment shall be any one of the combination of the following with concentration shown against each in aqueous emulsion:

Chemicals (E.C.S.) -	Concentration
Chlorpyrifos	- 1.0% (by weight)

24.0.3 TREATMENT FOR MASONRY FOUNDATION

The bottom surface and sides (upto a height of 30 cms. from the bottom) of the excavation made for masonry foundations and basements shall be treated with the chemical emulsion mentioned above at 5 litres per Sqm of surface area.

24.0.4 TREATMENT TO BACKFILL EARTH

As the masonry foundations and retaining walls of the basement come up, the backfill in immediate contact with the foundation structure shall be treated with the chemical emulsion at the rate of 7.5 litres per Sqm of the vertical surface of the sub-structure for each side. The earth is usually returned in layers and the treatment shall be carried out in similar stages. The chemical emulsion shall be directed towards the concrete or masonry surfaces of the columns and walls so that the earth in contact with these surfaces is well treated with the chemical.

24.0.5 TREATMENT FOR R.C.C. FOUNDATIONS

The treatment described in 2 and 3 above applies essentially to masonry foundations where there are voids in the masonry through which termites can

seek entry into the superstructure. Hence the foundations require to be completely enveloped by a chemical barrier. In the case of RCC foundations the concrete is dense being a 1:2:4 mix or richer, the termites are unable to penetrate it. It is therefore unnecessary to start the treatment from the bottom of excavations. The treatment shall start at depth of 50 cms. below the ground level except when ground level is raised or lowered by filling or cutting after the foundations have been cast. In such cases the depth of 50 cms. shall be determined from the new soil level resulting from filling or cutting mentioned above and soil in immediate contact with the vertical surface of RCC foundations. From this depth the backfill around the columns, beams and RCC basement walls shall be treated at the rate of 7.5 litres per Sqm. The other details of the treatment shall be as laid down in 3 above.

24.0.6 TREATMENT OF TOP SURFACE OF PLINTH FILLING

The top surface of the consolidated earth within the walls shall be treated with the chemical emulsion at the rate of 5 litres per Sqm of the surface before the sand bed or sub-grade is laid. If the filled earth has been well rammed and the surface does not allow the emulsion to seep through, holes upto 50 to 75 mm deep at 150 mm centres both ways may be made with 12 mm dia MS rod on the surface to facilitate absorption of the emulsion.

24.0.7 TREATMENT OF JUNCTION OF WALLS AND FLOOR

Special case shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from the ground level (where it had stopped with the treatment described in 3 above) upto the level of the filled earth surface. To achieve this, a small channel 3 x 3 cms shall be made at all the junctions of wall and columns with the floor (before laying the sub-grade) and rod holes made in the channel upto the ground level 15 cms. apart and the rod moved backward and forward to break up the earth and chemical emulsion poured along the channel at the rate of 7.5 litres per Sqm of the vertical wall or column surface of the sub-structures so as to soak the soil right to the bottom. The soil should be tamped back into place after this operation.

24.0.8 TREATMENT TO SOIL ALONG EXTERNAL PERIMETER OF BUILDING

After the building is complete, the earth along the external perimeter of the building should be rodded at intervals of 15 cms. and to a depth of 30 cms. The rods should be moved backward and forward parallel to the wall to break up the earth and chemical emulsion poured along the wall at the rate of 7.5 litres per sqm. of vertical surfaces. After the treatment, the earth should be tamped back into place. Should the earth outside the building be graded on completion of building, this treatment should be carried out on the completion of such grading. In the event of filling being more than 30 cms the external perimeter treatment shall extend to the full depth of filling up to the ground level so as to ensure continuity of the chemical barrier.

24.0.9 TREATMENT OF SOIL UNDER APRON ALONG EXTERNAL PERIMETER OF BUILDING

Top surface of the consolidated earth over which the apron is to be laid shall be treated with chemical emulsion at the rate of 5 litres per sqm of the vertical surface before the apron is laid. If consolidated earth does not allow emulsion to seep through holes up to 50 to 75 mm deep at 150 mm centres both ways may be made with 12 mm dia mild steel rod on the surface to facilitate saturation of the soil with the chemical emulsion.

24.0.10 TREATMENT OF SOIL SURROUNDING PIPES WASTES & CONDUITS

When pipes, waste and conduits enter the soil inside the area of the foundation, the soil surrounding the point of entry must be loosened around each such pipe waste or conduits for a distance of 15 cms and up to a depth of 7.5 cms before the treatment is commenced. When they enter the soil external to the foundations, they shall be similarly treated unless they stand clear of the walls of the building by about 7.5 cms, for a distance of over 30 cms.

24.0.11 SPRAYING EQUIPMENT

A pressure pump shall be used to carry out spraying operations to facilitate proper penetration of chemicals into the earth.

24.0.12 The above specifications are in line with the I S code of practice for Anti - termite measure in buildings, IS: 6313(part -II) - 1981 first revision.

25.0 EPOXY SELF-LEVELING HEAVY DUTY BASE SCREED

CLEAN TECH ESLS

Solvent free, self-smoothing, non- pigmented epoxy screed flooring, which is laid at a thickness of minimum 2-3 mm and used as a base screed. CLEAN TECH ESLS is jointless, monolithic, smooth, non-porous, and after laying the same, we can carry out the machinery erection etc. and at the final stage it is possible to do the over lay CLEAN TECH SL(M) topping.

CLEAN TECH ESLS not only minimizes undulations of VDF / IPS concrete floor but also provides strong base screed with high compressive strength of 70 – 80 N.

Advantages:

- ⇒ Jointless flooring system with uniform thickness throughout the applied area.
- ⇒ Unlike conventional screeds, CLEAN TECH ESLS is applied in a single application, of desired thickness over a primed surface, resulting in durable and abrasion-resistant flooring.
- ⇒ A unique formulation of CLEAN TECH ESLS renders the flooring abrasion resistant, capable of absorbing impact loads, chemical resistant to various chemicals.
- ⇒ Easily cleanable.
- ⇒ Very-low wear & tear compared to a floor-coating.

Performance Data:

Tests	Results
Compressive Strength	80 N/mm ² (7 days)
Flexural Strength	40 N/mm ² (7 days)
Tensile Strength (Under tension)	20 N/mm ² (14 days) (Concrete failure)
Bond Strength	3.5 N/mm ² (Concrete failure)

26.0 EPOXY FLOORING

CLEAN TECH SL(M)

Epoxy Self-Leveling system CLEAN TECH SL(M), which is a seamless hygienic self-leveling system based on latest solvent free polymer technology. It is a solvent free, 100% solid self leveling epoxy flooring designed to provide an aesthetic, smooth surface in industrial environments with light to moderate traffic and moderate chemical exposure. The unique formulation gives the surface an excellent gloss as well as abrasion resistance.

Advantages :

- ⇒ Excellent physical and chemical resistant properties.
- ⇒ Variety of colours to suit customer's requirements
- ⇒ Seamless, jointless and monolithic
- ⇒ Conforms to global migration standards laid down in US-FDA 175 – 300

Performance Data:

Tests	Results
Compressive Strength	70 N/mm ² (7 days)
Flexural Strength	40 N/mm ² (7 days)
Tensile Strength (Under tension)	20 N/mm ² (14 days) (Concrete failure)
Bond Strength	3.5 N/mm ² (Concrete failure)

27.0 ANTISTATIC EPOXY FLOORING

CLEAN TECH ASF (M)

Epoxy Self-leveling Antistatic Flooring

CLEAN TECH ASF (M) is a three-component seamless epoxy resin based floor system, which provides a static-dissipating surface. It is applied at a nominal 2 to 3 mm thickness. **CLEAN TECH ASF (M)** is jointless, solvent-free, self-

smoothing, monolithic, smooth, non-porous, hygienic, chemically resistant and easy- to- clean floor topping.

Advantages

- ⇒ Resists build up of static electricity and electrically conductive.
- ⇒ Excellent chemical resistance
- ⇒ Seamless, dense surface – easily cleaned and hygienic
- ⇒ Monolithic and joint-less floor.

Performance Data:

Tests	Results
Compressive Strength	70 N/mm ² (7 days)
Flexural Strength	40 N/mm ² (7 days)
Tensile Strength (Under tension)	20 N/mm ² (14 days) (Concrete failure)
Bond Strength	3.5 N/mm ² (Concrete failure)

Application Procedure:

1. Surface preparation by abrading the surface manually / mechanically to remove dirt, oil and other contaminations. All dust and debris should be swept or vacuumed from the surface.
2. Laying of copper strip
3. Application of 1 coat of conductive adhesive primer
4. Laying of 2 mm thick antistatic self leveling CLEAN TECH ASF(M).

28.0 HYGIENE PU WALL COATING

WALL TECH 2KWPU

Two component water based Polyurethane finish wall coating system and it has the following advantages:

Advantages:

- ⇒ Meets FDA / USDA requirements for food contact.
- ⇒ Wall Tech 2KWPU remains non-yellowing and is totally unaffected by UV light.
- ⇒ Easy to apply by brush, roller or spray.
- ⇒ True water based technology / environmentally safe.
- ⇒ Excellent resistance to mould and fungus growth.
- ⇒ Self sterilizing properties and is ideal for usage in the pharmaceutical manufacturing environment and in hospitals.
- ⇒ Easy to clean / wash.

PERFORMANCE DATA:

Tests	Standards	Results
Impact Resistance	BS 2782 Part 3	No failure (0.9 kg load dropped 45 cm)
Direct Pull Adhesion	ASTM 4541	63 Kg / cm ²
UV Resistance	ASTM G 53	500 hours QUV-B no loss of gloss, no color change.
Humidity Resistance	BS 3900 Part F2	Unaffected 5,000 hours exposure
Bacteria Resistance	BS 4618 Section 4.5	Excellent
Mould Resistance	BS 3900 Part G6	Excellent
Scratch Resistance	BS 3900 Part E2	No Failure 2.5 kg load
Fire Propagation	BS 476 Part 6 BS 476 Part 7	Class 0 Class I
Water Vapour Permeability	ASTM D 1653	1.2 gm / mm / m ² / 24 hours

APPLICATION PROCEDURE:

- ⇒ Proper Surface Preparation
- ⇒ Application of two to three coats of Acrylic based putty for smoothening the surface
- ⇒ Application of one coat of WB primer
- ⇒ Application of first coat of water based Polyurethane wall coating – Wall Tech 2KWPU Application of second coat of Wall Tech 2KWPU

CLEAN TECH WPUC

It is water based polyurethane, which is semi gloss, with excellent water wash ability, and chemical resistance based on superior technology. It is far more superior than the conventional single component water based PU coatings due to special hardener and special additives.

Advantages :

- ⇒ Better adhesion and flexibility.
- ⇒ High chemical, UV and weather resistance
- ⇒ As compared to normal single component water based PU coatings, it is better in water washability characteristic.
- ⇒ Improved performance over manually prepared concrete surfaces.
- ⇒ Improved performance for resistance to chlorine.
- ⇒ Antifungal, anti bacterial characteristics

Performance data:

Tests	Standards	Results
Abrasion resistance	ASTM D 4060	60 mgm weight loss per 500 cycles – 1kg load – CS10 wheel.
Impact resistance	BS 2782 part 3	No failure [0.9 kg (1.98 lbs) load dropped 45 cm (18 inches)]
Direct pull adhesion	ASTM 4541	35 Kg/cm ² (500psi) - Concrete (Concrete failure)
Water vapour permeability	ASTM D 1653	4.70 X 10 ⁻⁶ per m.cm
Pencil hardness	ASTM D3363	HB
UV resistance	ASTM G53	500 hours QUV-B no loss of gloss, no colour change
Bacteria resistance	-	Excellent
Mould resistance	BS 3900 part 6	Excellent

Application procedure:

- ⇒ Surface preparation of the walls to remove loose particles etc.
- ⇒ Application of 2 coats of high strength white cement based CLEAN TECH wall putty.
- ⇒ Proper sanding of the above surface.
- ⇒ Smoothing the above surface using acrylic wall putty.
- ⇒ Application of one coat of water based epoxy primer - CLEAN TECH WB primer white.
- ⇒ Application of first coat of CLEAN TECH WPUC.
- ⇒ Application of final coat of CLEAN TECH WPUC.

29.0 ACRYLIC INTERNAL WALL COATING FOR NON-CRITICAL AREAS

CLEAN TECH SWC

Single component water based acrylic coating with good adhesion to the surfaces. It is free from solvent fumes. It is an ideal, protective coating designed to resist UV and weather. It is recommended for application in the following Areas.

Advantages

- Better adhesion and flexibility.
- UV and weather resistance.
- Improved performance over manually prepared concrete surfaces.
- Easy to wash
- Can be easily applied by brush, roller or airless spray

Application procedure:

- Surface preparation of the walls to remove loose particles etc.
- Application of 2-3 coats of CLEAN TECH Wall Putty.
- Application of one coat of CLEAN TECH SWC Primer

- Application of two coats of acrylic coating of CLEAN TECH SWC

30.0 FALSE CEILING

30.1 General - Coverings are fixed on to the ceiling to give decorative appearance, to conceal projections, such as beams occurring underneath floor slab, to provide a false ceiling, to obtain special acoustic effects, insulation against heat and cold, etc.

Fixing details using the following boards and others are covered herein:

- | | | |
|---|---|---|
| a) Insulated board | : | IS: 3348-1965 |
| b) Hardboard | : | IS: 1658-1977 |
| c) Plaster of Paris Ceiling &
Plaster of Paris tiles | : | IS: 2547(Parts 1 & 2)-1976 |
| d) Gypsum plaster board | : | IS: 2095-1996 |
| e) Plywood and blackboard | : | IS: 303-1989, IS: 1328-1996 (Plywood)
IS: 7316-1974, IS: 710-1976, IS: 1659-
1900 (Block board) |
| f) Asbestos cement building
board | : | IS: 2098-1997 (Plain) IS: 459-1992
(Corrugated) |
| g) Wooden cover fillets for ceiling | | |
| h) Cloth ceiling | | |
| i) Aluminium sheet ceiling | | |
| j) Expanded polystyrene ceiling | | |
| k) Mineral wood board | | |

The fabrication and fixing of timber ceiling is covered by IS: 5390-1984.

30.2 Preparatory work

- a) Wooden or metal framework, consisting of longitudinal bearers and cross bearers by means of which the ceiling board are supported, shall be designed for structural strength and stability as per IS: 883-1994.
- b) The suspenders from RCC slabs for supporting the framework for false ceiling shall be of sufficient length to reach the ceiling frame.
- c) Ceiling boards, less than 5 kg/m² in mass, can be directly fixed to RCC by means of fixing plugs, bolts, etc.
- d) Where double ceiling boards are provided, such as, in air conditioning installations, cold storage rooms, the first layer of ceiling board may be fixed to the ceiling with plugs or other fixing devices in the concrete slabs at required spacings.
- e) Typical details of framework and methods of its suspension are shown in Fig.1 and Fig.2

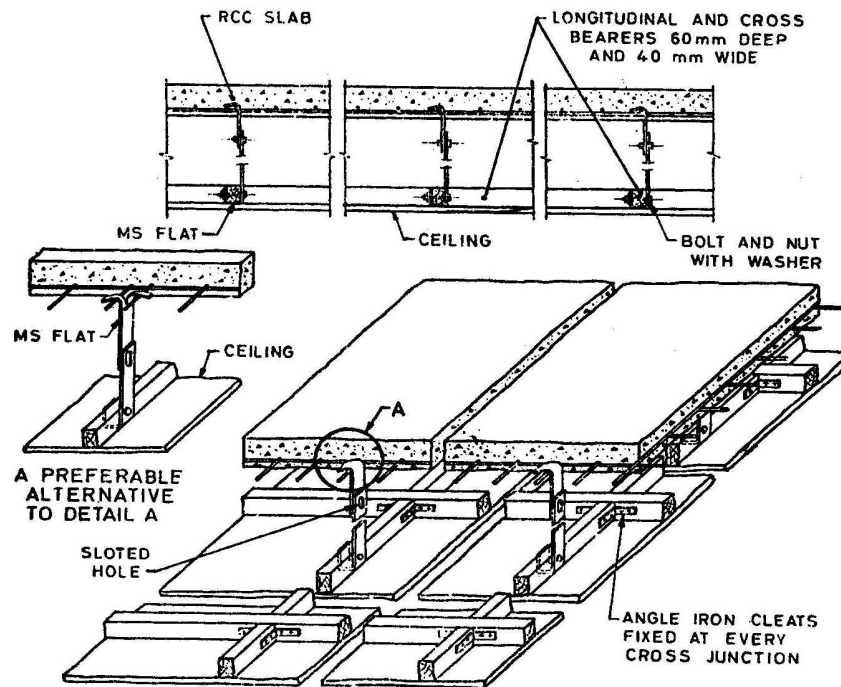
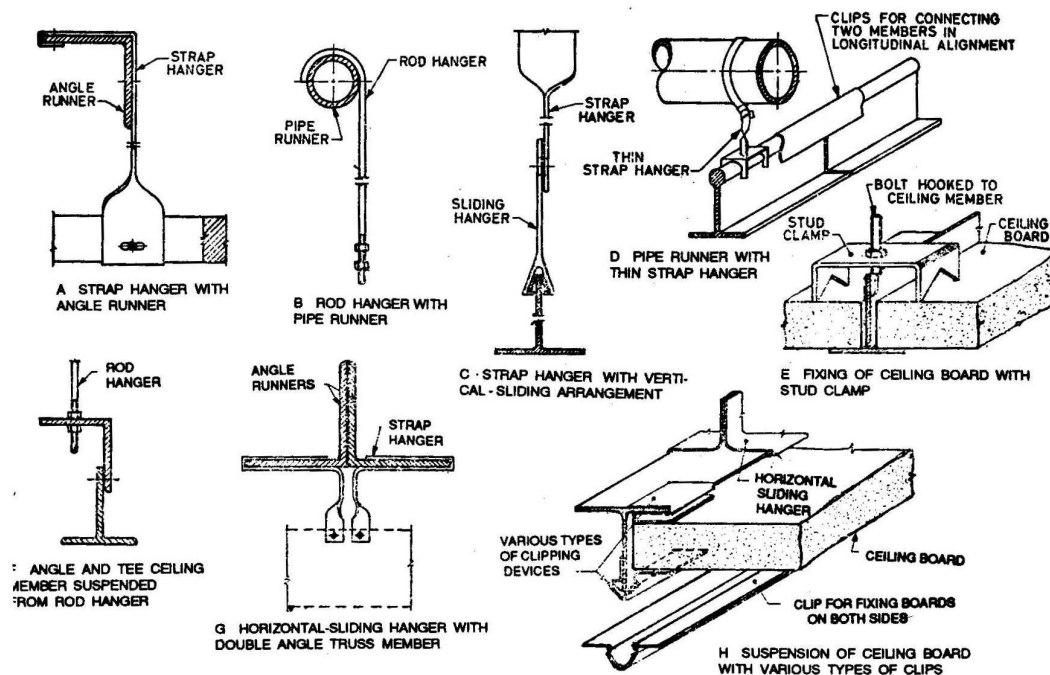


Fig. 1 Details of ceiling frame suspended from RCC slab



Different methods of attachment of hangers to top members are illustrated in A,, B,C and G and to ceiling frames are illustrated in A,C,D,F and G.

Use of clips, studs and hooks for fixing bolts are illustrated in H and E

Fig. 2 Details showing some typical methods of suspension of ceiling frame from structural members.

30.3 Fixing of coverings

30.3.1 Insulating building board

a) Materials

The timber for framework and beading shall be treated and chosen from any of the species in IS: 3629-1986. Insulating building boards may be particle boards (low density) to IS: 3129- 1985 or fibre insulating boards to IS: 3348-1965. Nails, conforming to IS: 723-1972 shall be long enough to cover the thickness of board plus 25 mm. Galvanized lost head nails to IS: 6738-1972 of 2.80 mm dia may be used when joints are left exposed. Where joints are to be covered by beading, galvanized felt nails of 2.50 mm dia conforming to IS: 6730-1972 may be used. Wood screws shall conform to IS: 6760-1972.

b) Fixing

Cut the boards to the required size. The edges shall be slightly sand papered to make them smooth. The framework with battens, size ranging from 60 to 75 mm shall then be fixed. Aluminium frame may also be used instead of timber frame. The building board shall then be fixed with lengths parallel to all joints centered over the framing members. Where the joints are to be covered the boards shall be spaced 3 to 6 mm apart. Where the joints are to be exposed the sheets shall be butt jointed with their edges abutting each other. The boards are first nailed to intermediate framing member proceeding from the centre of the board outwards, the edges being nailed last.

1) Where joints are exposed, the outer row of nails shall be at 100 mm centres and about 12 mm from edge of the sheet. The rows in the middle of the sheet shall be at 20 mm centres. Nails in the outer rows on either side shall be paired and not staggered. Nails shall be countersunk in the underside of the board.

2) Where joints are to be covered with beading, the procedure is the same as in (1) above, except that in the outer rows, the nail spaced at 200 mm may be staggered. The beadings shall then be fixed over the sheets with screws at 200 mm centres.

3) The exposed side shall be truly level; joints truly parallel and perpendicular to the walls.

30.3.2 Hardboard

a) Materials

Timber shall conform to IS: 5390-1984. The hardboard shall conform to IS: 1658-1977. The other materials shall be as per 3.1 (a).

b) Fixing

1) The framework and board shall generally be fixed. Wood screws may be used.

2) The joints may be normally filled with plaster. If the hardboard has to be cement plastered the joints shall have a gap of 6 mm covered with scrim and bedded in cement plaster before the finishing coat is applied.

- 3) The finishing shall be as in 6.3.1. (b) (3).

30.4 Plaster of Paris

a) Materials

Timber for framing shall conform to IS: 5390-1984. Plaster of Paris shall conform to IS: 2547 (Parts 1 and 2)-1976. The other materials shall be as in 6.3.1. (a).

b) Fixing

1) In case of sloping roofs, wooden battens of suitable section (50 mm x 60 mm) shall be firmly fixed as main supports, to the underside of the beams at required centres by means of bolts and nuts. In case of flat roofs, treated battens shall be securely fixed to the walls and pillars by holding down bolts and shall be fastened to the slabs above with iron straps or mild steel bars anchored therein. Cross battens (treated) of 50 mm x 40 mm at about 400 mm centres shall then be fixed at right angles to the main battens. The underside of the framework shall be true to planes and slopes. Aluminium frame may also be used if specified.

2) Wooden strips or laths 25 mm x 6 mm shall be fixed to the cross battens in parallel rows with felt nails. The strips shall be butt jointed and joints staggered.

3) Rabbit wire mesh shall be fixed with rails of a pitch of 150 mm to 200 mm to the underside of wooden strips. The wire mesh shall be straight, tight and true to planes and slopes without any sagging and slightly below the underside of the laths.

4) Plaster of Paris shall be mixed with water to a workable consistency. The plaster shall be applied to the underside of laths over the rabbit wire mesh in suitable sized panels and finished to a smooth surface by steel trowels. The thickness over the laths shall be as specified but not less than 12 mm. Joints shall be finished flush ; the surface shall be smooth and true to plane, slope or curve as required.

30.4.1 Plaster of Paris tiles

a) Materials

Timber for making framework shall be from any species in IS: 5390-1984. Plaster of Paris shall conform to IS: 2547 (Parts 1 and 2)-1976; thickness of tiles shall be not less than 12 mm. Hessian cloth shall conform to IS: 2818(Part 1)-1990; Hessian cloth shall be of an open webbed texture.

b) Preparation of tiles

Tiles of plaster of Paris reinforced with Hessian cloth shall be prepared to the required size. The maximum size shall be limited to 750 mm in each direction. The tiles may be made on a glass sheet with wooden surrounds; a thin coating of non-staining oil may be given to the glass sheet for easy removal of tiles. Plaster of Paris shall be evenly spread to about half the thickness and then Hessian cloth spread over it, on this, plaster of Paris is spread again to the full

thickness. Tiles shall be allowed to set for an hour and then removed to dry and harden for about a week. A good tile will give a ringing sound when struck.

c) Fixing

The timber frame shall be so made that each tile has supporting scantlings to fix them. Aluminium frame may also be used. Tiles may be fixed to the cross battens with 40 mm long brass screws to IS: 6760-1972 at 200 mm centres. Tiles may be laid adjacent to each other without leaving any gap. The screws shall be at least 15 mm away from the edge. Holes for screws shall be drilled. The countersunk heads of screws shall be covered with plaster of Paris and smoothly finished. When unbroken surface is desired, joints shall be filled with plaster of Paris and troweled smooth.

30.5 Gypsum plaster board

a) Materials

The boards shall conform to IS: 2095-96. Nails shall conform to IS: 723-1972. The length of the nails shall be 30 mm for boards 10 mm thick and 40 mm for 12.5 mm or 16 mm thick boards. Screws shall conform to IS: 6730-1972. Steel screws without brass or nickel coating shall not be used. Screw sizes shall be 3.10 or 3.45 mm; length shall be 30 mm for 10 mm thick board and 35 or 40 mm for 12.5 mm and 16 mm board.

b) Fixing

The frame work shall be fixed as in 3.1 (b). Joints may be 6 mm wide. Jointing may be in a decorative pattern. The joints may be finished with a filling of gypsum plaster or other materials; after filling the joint, a thick skin of the finishing material shall be spread 50 mm on either side and troweled dry. When metal scrim is used, a stiffer plaster may be necessary. The joints may also be left open if desired.

30.6 Plywood and block board

a) Materials

Timber for framework shall conform to IS: 5390-1984. Plywood shall conform to IS: 303-1989 or IS: 710-1976 or IS: 7316-1974 or IS: 1328-1982 or IS: 5509-1980. Block board shall conform to IS: 1659-1990, screws shall conform to IS: 6760-1972.

b) Fixing

The fixing shall be as in 6.3.1. (b) ; except that for boards in thickness 4 to 10 mm the spacings may vary from 450 to 600 mm for longitudinal battens and 600 to 1200 mm for cross battens ; for boards above 10 mm thick, the spacings may be 600 to 900 mm for longitudinal battens and 900 to 1300 mm for cross battens. The spacing of fixing countersunk screws may be adjusted according to thickness of board. Joints if left out open shall be filled with painters putty and brought to level ; joints may also be left open. The joints may be rebated or tongue and grooved.

The ceiling shall be finished by hand-sanding and waxed or polished or

clear

varnished or painted as required (see section 15).

30.7 Asbestos cement building board

a) Materials

Timber for framework can be any of the species in IS: 5390-1984; asbestos board shall conform to IS: 2098-1964; screws shall conform to IS: 6730-1972.

b) Fixing

Framework shall be fixed. The asbestos board shall be laid truly parallel or perpendicular to the walls and shall be fixed to the battens with countersunk screws by using metal channels and clips. Holes shall be drilled at least 12 mm from edge. They should be butt jointed. If a gap of 3 to 6 mm between sheets is given the gap should be covered with wooden beading or similar material. No finishing treatment is necessary.

30.8 Wooden cover fillets beading

a) Materials

Timber for framework may be any of the species of IS: 5390-1984. Screws shall conform to IS: 6730-1972. Beading shall be planed, smooth and true on the rear surface. It may be 12 mm x 40 mm or as specified.

b) Fixing

The beading shall be fixed centrally over the butt joints between two timber planks with screws in two rows on either side of joint. The junction of beading shall be fully mitred or as specified. The beadings shall be finished smooth.

30.9 Aluminium sheet

a) Materials

The framework may be made of aluminium 'T' grid and trays of aluminium alloy sheets 19000 or 31000 of IS: 737-1986. The grid shall be made of extruded aluminium 'T' section of 63400 or Wp of IS: 733-1983. The fillings shall be made out of aluminium or rust proofed steel.

b) Fixing

The ceiling may be formed as an exposed grid or a concealed grid using the above sections. The aluminium false ceiling may be left as it is if anodized or painted with acrylic resin paint.

3.10 Mineral wood board

a) Materials

Timber for ceiling shall be from IS: 5390-1984; nails to IS: 723-1972, screws to IS: 6730-1972 and mineral wood to IS: 3677-1985.

b) Fixing

A metal 'T' grid shall be suspended first and mineral wool board may be cut to size and stuck with suitable adhesive. For timber framework, the mineral wool board shall be stuck with an adhesive. Similar procedure may be followed with local modifications, as necessary, for different ceilings.

30.11 Fixing devices

30.1.1 Types

The fixing devices covered are as below

- a) Expansion wall plugs,
- b) Expansion shells,
- c) Caulked-in anchor devices, and
- d) Butt-in devices.

30.11.2 Fixing

Proper devices and tools ensure a neat fixing work with minimum effort and little damage, and the fixtures will have adequate strength and durability. Special devices are also available for resisting dampness, chemical attack, thermal effects, etc. Details of fixing devices are given in IS: 1946-1961.

Fixing devices, mentioned above are for solid walls. Devices for hollow walls are also coming into vogue.

Note Since the date of publication of this standard several new innovations have been introduced; the trade may be consulted for more information.

GENERAL TECHNICAL SPECIFICATION – PLUMBING AND SANITARY

1.0 GENERAL INSTRUCTION:

1.01.1 System description of Plumbing & Sanitary Works

The plumbing system is designed based on National Building Code and Local Bylaws. Based on the above standards the entire plumbing system is designed keeping in the consideration the adequate water and pressure available at all the user points. The source of water supply is from existing network available in the campus and bought out water supply. The reticulation of water supply system shall be with a gravity supply system. A constant pressure pressure of 0.7 Kg. / Sq.cm at remote point of use.

National building Code for Water Supply, drainage and Sanitation. Part IX Plumbing services section 1 and 2. The installation shall also be in conformity with the bylaws and requirements of the local authority in so far as these become applicable to the installation. Wherever this specification calls for, a higher standard of materials and/or workmanship than those required by any of the above regulations and standards, then this specification shall take precedence over the said regulations and standards.

Wherever the specifications and drawings require something that may conflict with the regulations, the regulations shall govern. This shall be referred to the Construction Managers /Professional Team for approval.

1.0.2 Drawings, Specifications and Deviations

The drawings and specifications lay down minimum standards of equipment and workmanship. Should the tenderer wish to depart from the provisions of the specifications and drawings either on account of manufacturing practice or for any other reasons, he should clearly draw attention in his tender to the proposed points of departures and submit such complete information, Drawings and specifications will enable the merits of the deviations to be fully appreciated. In the absence of any such deviation list, it will be deemed that the tenderer is fully satisfied with the intents of the specifications and the drawings and their compliance with the statutory provisions and local codes. All deviations or departures not brought out to the notice shall be disregarded.

1.0.3 Tools and Spare Parts

All the tools and tackles, scaffolding and staging required for erection and assembly of the installation covered by the contract shall be obtained by the contractor himself. All other material such as foundation bolts; nuts etc, required for the installation of the plant shall be supplied and included in the contract. Tenderer shall include spares recommended by him for two years operation [commencing from the Date of Issue of

the Certificate of Substantial Completion] for each type of equipment covered by the specification.

1.0.4 Working and construction drawings

The contractor shall prepare shop drawings and all work shall be according to approved working drawings. Shop drawings shall give all dimensions and shall incorporate the requirements of the clients/Construction Managers / Professional Team. Approval of drawings does not relieve the contractor of his responsibility to meet the intents of the specifications. All such drawings for approval shall be submitted in 6 copies to the Construction Managers / Professional Team. In addition, the contractor shall submit manufacturer's details and get them approved before ordering. This has to be done whether the materials / equipment are one of the approved makes or not.

1.0.5 Testing and Inspection

The contractor shall carry out tests on different equipment and system in total as specified in various sections of the tender in the presence of the Construction Managers / Professional Team in order to enable them to determine whether the plant, equipment and installation in general comply with the specifications. All equipment shall be tested after carrying out the necessary adjustments and balancing to establish equipment ratings and all other design conditions. The test data shall be submitted in Acceptance Test Form.

14.0.6 Handing over requirements

The plant shall be handed over after satisfactory testing along with 6 sets of the following documents along with CDs (Soft copy).

1. Detailed equipment data in the approved perform
2. Manufacture's maintenance and operating instructions manuals
3. Set of as built drawings, layouts, piping, ducting, cable routing, cable schedules etc,
4. Approved test readings of all equipment and installations
5. Inspection certificates
6. Certificates of approval from statutory or Local Authorities for the operation and maintenance of the installations, wherever such approval or certification is required. This shall include Application filed along with enclosures and receipts of fees paid and deposits made
7. Warranty / guaranty certificate for all equipments
8. List of recommended spares together with list of suppliers and their contact details

9. Certificate from the contractor that he has cleared the site of all debris and litter caused by him. However, contractor has also to periodically clear the site from all the debris, which are generated from his part of scope
10. Undertaking that all the materials supplied by him at site are fully tax paid and shall produce all documentation for satisfaction of the Construction Managers / Professional Team or taxation authorities Submission of the above documentation shall form a precondition for final acceptance of the plant and installation and final payments

1.0.7 Statutory approvals inspection

The contractor shall be fully responsible for meeting all the statutory obligations and local inspectorates wherever applicable to the works carried out by them. The contractor should prepare all working drawings and obtain approval of competent authorities and also have the equipment and installation inspected and got approved.

All obtaining approval fee and deposit towards statutory approval and inspection paid against demand in writing from the appropriate authority will be reimbursed on submission of original receipts. All other expenses for submission and approval of the various and relevant statutory / bodies shall be embodied in the tender prices.

1.0.8 Material

- a. Materials shall be of the best approved quality obtainable and unless otherwise specified they shall conform to the respective Indian Standard Specification. Samples of all materials shall be got approved before placing order and the approved samples shall be deposited with the HLL.
In case of non-availability of materials in metric sizes, the nearest size in FPS units shall be provided with prior approval of the HLL for which neither extra will be paid nor shall any rebate be recovered.
- b. If directed, materials shall be tested in any approved testing laboratory and the contractor shall produce the test certificate. The entire charges for original as well as repeated tests shall be borne by the Contractor. If required by the Project Authority, the Contractor shall arrange to test portion of work at his own cost in order to prove their soundness and efficiency. If, after any such test, the work or portion of work is found, in the opinion of the HLL Engineer-in-charge, to be defective or unsound, the Contractor shall pull down and re-do the same at his own cost. Defective material also shall be removed from the site.
- c. It shall be obligatory for the contractor to furnish certificates if demanded by the HLL Engineer-in-charge from manufacturer or the material supplier that the work has been carried out by using their material and installed/fixed as per their recommendations.

- d. It shall be obligatory for the contractor to furnish certificate if demanded by HLL Engineer-in-charge from manufacturer or the material supplier, which using their material and installed/fixed as per their recommendations has carried out the work.

2.0 INTRENAL PLUMBING AND SANITARY WORKS

2.0.1 SANITARY FIXTURES AND C.P FITTINGS

2.0.1.1 General

The brass or gun metal fitting shall be of heavy quality and approved manufacture and pattern with screwed ends as specified. The fittings shall in all respects comply with the Indian Standard Specifications.

The Standard size of brass or gun metal fittings shall be designated by the nominal bore of the pipe outlet to which the fittings are attached. A sample of each kind of fittings shall be got approved from the Engineer-in-charge at site and all supplies made according to the approved samples. All cast fittings shall be sound and free from laps, blow holes and fittings. Both internal and external surfaces shall be clean, smooth and free from sand etc., Burning, plugging, stopping or patching of the casting shall not be permissible. The bodies, bonnets, spindles and other parts shall be truly machined so that when assembled the parts shall be axial, parallel and cylindrical with surfaces smoothly finished. The area of the water way of the fittings shall be less than the area of the nominal bore.

The fittings shall be fully examined and cleared of all foreign matters before being fixed. The fittings shall be fitted in the line in a workman-like manner. The joints and fittings shall be lead proof when tested to a pressure of 6 kg/sq.cm as described in para above and the defective fittings and joints shall be replaced or redone, without any extra cost.

2.0.1.2 Installation of fixtures and fittings

All Plumbing and Sanitary Fixtures and fittings should be 1st (Standard) quality and shall be stored in covered stores and handled carefully to prevent damage. The sanitary fittings shall be installed at the correct assigned positions as shown on the drawings and as directed by the Engineer-in-charge at site and shall fully meet with the aesthetic and symmetrical requirements as demanded by the Project Consultants. Fixtures shall be installed by skilled workmen with appropriate tools according to the Standard practice in the trade. Manufacturer's instructions shall be followed for the installation of the fixtures.

Fixtures in all toilets shall be as per our Interior Drawing, rigid, plumb and true to alignment. The outlet of water closet pans and similar appliances shall be examined to ensure that outlet ends are abutting properly on the receiving pipes before making the

joints. It shall be ensured that the receiving pipes are clear of obstruction. When fixtures are being mounted, attention shall be paid to the possibility of movement/settlement by other causes. A check shall be made to ensure that necessary anchoring devices have been provided for supporting water closets, lavatory basin sinks, flushing cisterns and other appliances. Where the built-in types of brackets are used, they shall be securely fixed to the walls and slabs by approved means. It shall be ensured that while fixing the fixtures and fittings, no tool marks or scratches are developed. All steel brackets and supports shall be painted.

2.0.1.3 Protection of fixtures

Care shall be taken at all times, particularly after fixing to protect fixtures from damage. All offsets shall be temporarily plugged during progress of work to prevent obstruction. Fixtures shall be finally cleaned to the satisfaction of the Engineer-in-charge at Site.

3.0 TOILET FIXTURE

3.0.1 General

All fixtures shall be fixed in a neat workman like manner true to line and as recommended by the manufacturer or shown in the drawings. Care shall be taken to fix all fixtures, brackets and accessories by proper bolts and nuts (expansion bolts). Care shall be taken in fixing all approved chromium plated (CP) fixtures and accessories so as not to leave any tool marks or damages on the finish. The contractors shall be responsible on the rectification works. All such fixtures shall be tightened with fixed spanners. Use of 'Stilton' type pipe wrenches with toothed jaws shall not be allowed.

All fixtures shall be thoroughly tested after connecting the drainage and water supply system. All fixtures shall be thoroughly finished and any leakage in piping valves and waste fittings corrected to the complete satisfaction of the Construction Managers / Professional Team. Upon completion of the work, all labels, stickers, plaster, etc. shall be removed from the fixtures and all fixtures shall be cleaned with soap and water so as to present a neat and clean toilet.

3.0.1 .1 European water closet

General

The item pertains for providing white /color as described in the item description glazed vitreous chinaware European water closet with seat and cover of size as specified in the item description including fixing.

Material

Chinaware European water closet with integrated "P" or "S" trap shall conform to conforming to relevant BIS specification. Plastic seat and cover with CP brass hinges,

screws and rubber buffer shall be of approved make and heavy quality. Make shall be as described in the item description and as directed.

Fixing

The water closet shall be placed in position as shown in the drawing. If the pan or trap is damaged during handling or fixing, it shall be replaced by the contractor at his own cost. The pan, trap and CI pipe shall be jointed in 1:1 Cement Mortar with hemp yarn caulked. In case of floor mounted WC, the gap between WC and floor shall be finished with white / matching cement and sand and as directed.

Mode of measurement

The measurement and payment shall be by numbers or as specified in the schedule of quantities.

Rate

The rate shall include all material cost such as water closet, seat and seat cover, trap, cistern and its fittings and connection pipe including fixing in position, all lead, lift, labor and tools.

3.0.1.2 Indian Water Closet

Indian Water Closet white color Orissa pan type with porcelain `P` or `S` trap shall be provided with Cistern and necessary accessories etc., as required. Water Closet and trap shall be set in plain cement concrete 1:4 and flush with the floor. Each water closet shall be provided with 15mm CP health faucet with angle cock.

3.0.1.3 Shower unit

The shower unit shall be brass chromium plated with hot and cold single lever mixer unit with CP spout. The shower unit shall be fitted with an overhead shower set comprising of shower arm, rose etc., complete with wall flange. The make and model shall be as specified in the list of approved makes.

3.0.1.4 Sinks

They shall be Stainless steel of best quality and shall be supported on necessary brackets. Each sink shall be provided with 40 mm CP waste coupling, CP bottle trap, hot and cold single lever sink mixer as specified in the list of approved makes.

3.0.1.5 Urinal

General

The item pertains for providing white glazed vitreous chinaware / single, set, size, shape, color and make etc if any shall be as described in the item description. with necessary fittings (as specified in item description) and appliances including fixing.

Material

Urinal shall conform to relevant BIS specification. Material, type and size of brackets, dia of flush pipe, dia of spreader, quality of fittings etc shall be as described in the item description, conforming to relevant BIS specification and of approved quality and make.

Fixing

Urinal shall be fixed in position as shown in the drawing or as directed by the Engineer-in-Charge. Urinal shall be fixed to wall with brackets, CP screws, wooden plug etc. or as recommended by the manufacturer. The gap between urinal and wall shall be finished with white / matching cement.

Mode of measurement

The measurement and payment shall be by numbers or as specified in the schedule of quantities.

Rate

The rate shall include all material cost such as Urinal, waste coupling, CI brackets if required, spreader and connection pipe including fixing in position, bolts, screws, all lead, lift, labor and tools.

3.0.1.6 Urinal slab partition

General:

The item pertains for providing Marble or Granite slab partition of size, shape, thickness and color as described in item description including fixing.

Material

The partition slab shall be of Marble or Granite of size, shape, thickness and color as specified in the item description. It shall be polished on both sides, machine cut with exposed corners rounded. Cracked or damaged marble slab shall not be used in the work and shall be replaced if any by the contractor at his own cost and charges.

Fixing

Partition shall be fixed vertically, true in line, level and plumb as indicated in the drawing at proper height. 100 mm wide chases shall be cut in the wall and the partition shall be embedded at least 75 mm in the wall using 1:2:4 cement concrete or in CM 1:3 or as directed. After fixing the slab the chases cut in the wall shall be made good to original condition and cured properly for a period of minimum 7 days.

Mode of Measurement

The measurement and payment shall be by area in Square meter.

Rate

The rate shall include material cost, cutting, polishing on both sides, rounding and molding the edges, including fixing in position, all lead, lift, labor and tools.

3.0.1 .7 Wash basin

General

The item pertains for providing white/ colour as described in the item description glazed vitreous chinaware wash basin with or without pedestal of size, shape as specified in the item description including fixing.

Material

China ware Wash Basin with or without pedestal /as described in the item description, shall conforming to relevant BIS specification and C.P. brass Chain and plug shall be of standard pattern of approved quality and make etc. shall be as described in item description and as directed.

Fixing

The wash basin shall be fixed in position as indicated in the drawing. It shall be placed on the brackets over a pair of CI / MS bracket/ as described in the item description with plugs, clamps and screws or as ordered by the Engineer-in-charge. The gap between wash basin and wall shall be finished with white / matching cement and sand and as directed.

Mode of measurement

The measurement and payment shall be by numbers or as specified in the schedule of quantities.

Rate

The rate shall include all material cost such as wash basin, waste coupling, bottle trap, CI brackets and connection pipe including fixing in position, bolts, screws, all lead, lift, labor and tools.

3.0.1 .8 Pillar cock

General

The item pertains to provide chromium plated brass/as described in the item description pillar cock with specials including fixing.

Material

The Pillar cock shall be 15 mm nominal diameter or as specified in the item description. It shall be of CP brass/as described in the item description, approved and

heavy quality, and shall conform to relevant BIS specification. Make, model, CAT no. etc., if any shall be as mentioned in the item description.

Fixing

Pillar cock shall be fixed in position as indicated in the drawing or as directed by Engineer-in-Charge. Jointing shall be done with white zinc, spun yarn etc. A few turns of the fine hemp yarn dipped in linseed oil shall be taken over the threaded ends to obtain complete water-tightness. Leaky joint shall be remade to make it leak proof.

Mode of measurement

The measurement and payment shall be by numbers or as specified in the schedule of quantities.

Rate

The rate shall include all material cost including fixing in position, all lead, lift, labor and tools.

3.0.1.9 TOILET ACCESSORIES

3.0.1.10 Glass mirror

General

The item includes providing beveled/ plain edges glass mirror / as described in the item description, with/ without teakwood / Aluminum frame, size and shape as mentioned in the item description including fixing.

Material

Glass mirror shall be made out of best Indian glass of specified thickness. The make shall be either Hindustan Pilkington or Modi or Saint Gobian or as described in the item description. The mirror shall be made of clear glass with silvered polish and protective coat of copper sulphate. Backing shall be provided with 6 mm thick AC sheet or marine plywood or as mentioned in item description. In case of teakwood frame size, shape etc. shall be as mentioned in the item description and as directed. In case of Aluminum frame size, shape etc., shall be as mentioned in the item description and as directed.

Fixing

Glass mirror shall be fixed to proper line, plumb and level as indicated in drawing with 40 mm long CP brass screws, wooden raw plug, drilling hole and making good the wall to the original condition after fixing the glass mirror etc.

Mode of Measurement

The measurement and payment shall be by area in Square meters.

Rate

The rate shall include all material cost, cutting, polishing and beveling the edges of the mirror, backing materials, screws etc., including fixing in position, all lead, lift, labor and tools.

3.0.1 .11 Towel rod/ rail

General

The item includes providing Towel rod /rail of dia and length as mentioned in the item description including fixing.

Material

CP brass Towel rod / rail shall be of 20 mm diameter and 600 or 450 mm long as mentioned in the item description, with CP brass brackets, screws and wooden gut ties. Quality, make and model / CAT no. shall be as mentioned in the item description.

Fixing

The Towel rod / rail shall be fixed to proper line and level as indicated in drawing with 40 mm long CP brass screws, wooden raw plug/ cleats, drilling hole and making good the wall to original condition after fixing the towel rod / rail.

Mode of measurement

The measurement and payment shall be by numbers or as specified in the schedule of quantities.

Rate

The rate shall include all material cost including fixing in position, screws, raw plugs, all lead, lift, labor and tools.

3.0.1.12 Waste coupling

General

The item pertains to provide chromium plated brass or as described in the item description waste coupling of 32 mm NB. Size and shape etc., if any shall be as mentioned in the item description including fixing.

Material

The waste coupling shall be of CP brass/as described in the item description of approved and heavy quality of size and shape etc, if any shall be as mentioned in the item description. It shall conform to relevant BIS specification. Rubber plug and chain shall be of approved quality in standard length. Make, model, CAT No. etc. if any shall be as mentioned in the item description.

Fixing

Waste coupling shall be fixed to wash basin and sink etc shall be as indicated in the drawing with necessary specials as directed by Engineer-in-Charge. Jointing shall be done with white zinc, spun yarn etc. A few turns of the fine hemp yarn dipped in linseed oil shall be taken over the threaded ends to obtain complete water-tightness. Leaky joint shall be remade to make it leak proof.

Mode of measurement

The measurement and payment shall be by numbers or as specified in the schedule of quantities.

Rate

The rate shall include all material cost including fixing in position, all lead, lift, labor and tools.

3.0.1 .13 Bottle trap

General

The item pertains to provide chromium plated brass/as described in the item description bottle trap including fixing.

Material

The bottle trap shall be of CP brass or as described in the item description of approved and heavy quality of size, shape as mentioned in the item description. It shall conform to relevant BIS specification. Wall Flange and extension piece shall be of CP Brass in required length. Make, Model, Cat No. etc if any shall be as mentioned in the item description.

Fixing

Bottle trap shall be fixed to wash basin and sink as indicated in the drawing with necessary specials as directed by Engineer-in-Charge. Jointing shall be done with white zinc, spun yarn etc. A few turns of the fine hemp yarn dipped in linseed oil shall be taken over the threaded ends to obtain complete water-tightness. Leaky joint shall be remade to make it leak proof.

Mode of measurement

The measurement and payment shall be by numbers or as specified in the schedule of quantities.

Rate

The rate shall include all material cost including fixing in position, all lead, lift, labor and tools.

3.0.1 .14 Bib tap and stop cock

General

The item pertains to provide chromium plated brass/as described in the item description long body bib tap, short body bib tap and stop cock with specials including fixing.

Material

The long body Bib tap, short body bib tap and Stop cock shall be 15 mm nominal diameter or as specified in the item description. It shall be of CP brass or as described in the item description, approved and heavy quality, and shall conform to relevant BIS specification. Make, model, CAT no. etc if any shall be as mentioned in the item description.

Fixing

Long body Bib tap, Short body bib tap / stop cock shall be fixed to the pipe line with CP brass or GI specials, if required or as directed by Engineer-in-Charge. Jointing shall be done with white zinc, hemp yarn etc. A few turns of the fine hemp yarn dipped in linseed oil shall be taken over the threaded ends to obtain complete water-tightness. Leaky joint shall be remade to make it leak proof.

Mode of measurement

The measurement and payment shall be by numbers or as specified in the schedule of quantities.

Rate

The rate shall include all material cost including fixing in position, all lead, lift, labor and tools.

3.0.1.15 Towel rail

Towel rail shall be of C.P. with reinforced bends and circular flanges. The make and model shall be as specified in the list of approved makes. The bracket shall be fixed by means of stainless steel screws to wooden/plastic cleats firmly embedded in the wall.

3.0.1.16 Toilet Paper Holder

Toilet paper holder shall be of chromium plated. The make and model shall be as specified in the list of approved makes.

3.0.1.17 Towel Ring, Soap Tray, Etc.

These shall be of CP the make and model shall be as specified in the list of approved makes. These shall be fixed by means of stainless steel screws to wooden / plastic cleats firmly embedded in the wall.

3.0.1.18 Electric Hand Drier

The electric hand drier shall be twin blower type interpreted with timer range 0 to 3 minutes. The drier shall be fully automatic. The power requirement shall be 230V, 1PH, 50Hz 1700 watts. The drier shall be wall-mounted type. The make and model shall be as specified in the list of approved makes.

3.0.1.19 Soap Dispenser

The Soap dispenser shall be wall mounted type tough ABS plastic with soap pouch and pump system as per list of recommended makes. The capacity of dispenser shall be 500 ml

APPLICABLE CODE

Sl No	Sanitary Appliances	
1	IS: 774	Specification for flushing cistern for water closets and urinals (Other than plastic cistern).
2	IS: 775	Specification for cast iron brackets and supports for wash basins and sinks.
3	IS: 781	Specification for cast copper alloy screw down bib taps and stops valves for water services.
4	IS: 2548	Specification for plastic seats and covers for water closets: Part 2 Thermo plastic seats and covers.
5	IS : 1171	Basic requirement of water supply, drainage and sanitation.
6	IS: 2556	Specification for vitreous sanitary appliances (vitreous china) Part 2 specific requirements for wash-down water closets.
7	IS: 2556	Specification for vitreous sanitary appliances (vitreous china) Part 6 specific requirements or urinals, section 2 half stall urinals.
8	IS : 2556	Part – 4 - Specific requirement of wash basin.(third revision)
9	IS : 2556	Part – 5 – Specific requirement for laboratory sinks.(third revision)
10	IS: 2556	Specification for vitreous sanitary appliances (vitreous china)

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		Part 6 specific requirements or urinals, section 4 partition slabs.
11	IS: 2556	Specification for vitreous sanitary appliances (vitreous china) Part 11 specific requirements for shower rose.
12	IS: 2556	Specification for vitreous sanitary appliances (vitreous china) Part 12 specific requirements of floor traps.
13	IS : 13983	Specification for stainless steel sinks for domestic purposes.
14	IS 3311 : 1979	Specification for waste plug and its accessories for sinks and washbasin (first revision)
15	IS : 2556	Part 5 specific requirements of laboratory sinks (third revision)

4.0 WATER PIPE LINE AND FITTING MATERIALS

- G.I / C.P.V.C SDR11 & SCHEDULE40 Pipes Water supply lines within building for both Cold and Hot water system with specials.
- The joints shall be testes hydraulically to 10 Kg/cm² pressure as specified in the schedule. The leaky joints shall be remade and section re-tested at no extra cost. The period of test shall be for minimum 2 (two) hours.

4.0.1 CPVC PIPES AND FITTINGS FOR INTERNAL WATER DISTRIBUTION

Scope

This specification covers requirements, test methods, and methods of marking for chlorinated poly (vinyl chloride) plastic hot-and cold-water distribution system components made in one standard dimension ratio and intended for water service up to and including 180F (82C). These components comprise pipe and tubing, socket-type fittings, street fittings, plastic-to-metal transition fittings, solvent cements, and adhesives. Requirements and methods of test are included for materials, workmanship, dimensions and tolerances, hydrostatic sustained pressure strength, and thermo-cycling resistance. The components covered by this specification are intended for use in residential and commercial, hot and cold, potable water distribution systems.

The values stated in either inch-pound or SI units are to be regarded separately as standard. Within the text, SI units are shown in brackets. The values stated in each system are not exact equivalents therefore each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

Suggested hydrostatic design stresses and hydrostatic pressure ratings for pipe, tubing and fittings are listed in Appendix XI. Design, assembly and installation considerations are discussed in Appendix X2.

Reference Documents

ASTM Standards:

D 1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure

D1399 Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing and Fittings.

D1784 Specification for Rigid Poly (Vinyl Chloride) (UPVC) Compounds and Chlorinated Poly(Vinyi Chloride) (CPVC) Compounds

F 402 Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings²

F 493 Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

4.0.1.1 Terminology

Definitions:

The abbreviation for chlorinated poly(vinyl chloride) is CPVC. Plastic tubing denotes a particular diameter schedule of plastic pipe in which the outside diameter of the tubing is equal to the nominal size plus 1/8 in. (3.18 mm).

Standard material designation code—the chlorinated poly(vinyl chloride) material designation code shall consist of the abbreviation CPVC followed by two digits indicating the ASTM type and grade in Arabic numerals. Where necessary, a third and fourth digit shall be added to indicate the hydrostatic design stress for water at 73F [23C] in units of 100 psi [0.69 MPa].

Materials

Basic Materials Description—Chlorinated poly(vinyl chloride) plastics used to make pipe, tubing, and fittings meeting the requirements of this specification are categorized by two criteria; namely, basic short-term properties, and long-term hydrostatic strength

Classification

Pipe, Tubing, and Fittings—This specification classifies CPVC 4120 pipe, tubing, and fittings by a single standard dimension ratio which shall be SDR II, by a maximum continuous use temperature which shall be 180F [82C] and by nominal pipe or tubing diameters from 3/8 in.[9.5 mm] through 2 in. [50 mm].

Plastic-to-Metal Transition Finings—This specification classifies CPVC plastic-to-metal transition fittings intended for use up to and including 180F [82C] as CPVC-I80F on the basis of resistance to failure by thermo-cycling. Solvent Cements and Adhesives—This specification classifies solvent cements and adhesives meeting the requirements contained herein as CPVC Solvent Cement or CPVC Adhesive.

4.0.1.2 Requirement for pipe, Tubing & Fittings

Dimensions and Tolerances:

General:

Wall Minimums—Table 1 and Table 2 show wall thickness minimums. Calculated SDR 11 tubing wall thickness that fall below 0.068 in. [1.73 mm] shall be arbitrarily increased to that value. Calculated SDR 11 fitting wall thickness that fall below 0.102 in. [2.59 mm] for the fitting socket bottom, or 0.128 in. [3.25 mm] for the fitting body, shall be arbitrarily increased to these values.

Interference Fit—The diameters and tolerances in Table I and Table 2 provide for socket-type joints having an interference fit based on the major diameter of pipe and tubing having a degree of out-of-roundness. This does not necessarily imply interference based on the minor diameter of the pipe or tubing.

Out-of Roundness—The maximum out-of-roundness requirements shown in Table 1 and Table 2 for pipe, tubing, and fittings apply to the average measured diameter.

4.0.1..3 Plastic-Metal transition fittings

Basic Dimensions—Plastic parts of plastic to metal transition fittings shall meet the dimensional requirements of Table 1 and Table 2 where applicable with the following exceptions. Such parts shall be exempted from the requirements for inside diameter (waterway) and wall thickness tolerance.

Thread Dimensions—Transition fittings that rely on interference fit and sealant shall be threaded with American National Standard Taper Pipe Threads meeting the dimensional requirements.

Thread Tolerance— The manufacturing tolerance on CPVC threads, measured with a ring gage, shall be a maximum variation of 1½ turns large or small when measured in accordance with Test Method D 2122.

Starting Threads—The entering ends of external CPVC threads shall have a Blunt Start produced by making the width of the thread at the start approximately 50 to 75% of the full thread. The Blunt Start provides for easy entrance and protection of the thread, and shall be included in the measurement of thread length.

4.0.1..4 Hydrastatic sustained pressure

General

Pipe, tubing, and fittings (tested as assemblies) shall meet the minimum hydrostatic sustained pressure requirements of both test conditions shown in Table 5 when tested in accordance with TEST METHODS FOR PIPE, TUBING AND FITTINGS given below

Pipe and Tubing Quality

Test condition B shall be termed the primary sustained pressure test for pipe and tubing and shall be used for quality control. Test condition A shall be termed the secondary sustained pressure test for pipe and tubing and shall be used for periodic performance qualification. Failure to pass either test is cause for rejection.

Fitting Quality

Test condition A shall be termed the primary sustained pressure test for fittings and shall be used for quality control. Test condition B shall be termed the secondary sustained pressure test for fittings and shall be used for periodic performance qualification. Failure to pass either test is cause for rejection.

Thermo cycling

Plastic-to-metal transition fittings (other than metal socket-type transitions for use with adhesives assembled according to the manufacturer's instructions, shall not separate or leak when thermo cycled 1000 times between the temperatures of 60F and 180F [16C and 82C] in accordance with TEST METHODS FOR PIPE, TUBLING AND FITTINGS given below

4.0.1..5 Requirements for solvent cement & adhesive joints

CPVC Solvent Cements:

Note 6—CPVC solvent cements may exist which meet the requirements of the specification when used in accordance with the manufacturer's recommendations, without a primer or cleaner. It is recommended that those CPVC solvent cements which may be used without a primer or cleaner be clear or yellow in color. Otherwise, it is recommended that CPVC solvent cement requiring the use of 3 primer or cleaner be orange in color. Color identification is recommended to facilitate cement recognition to prevent the misuse of the cement and to the minimize the unintentional use of other cements that may fail at elevated service temperatures.

General CPVC solvent cements, for use in CPVC 41, plastic-to-plastic, socket-type joints shall meet the requirements set forth in Specification F 493.

Hydrostatic Burst Strength—2-in. [50-mm] CPVC solvent cement joints shall exceed the minimum hydrostatic burst strength requirements given in Table 6 after a maximum drying interval of 2 h when tested, Failure to pass the burst requirement at either temperature is cause for rejection.

Hydrostatic Sustained Pressure Strength— $\frac{1}{2}$ -in. [15-mm] CPVC solvent cement joints shall meet the requirements, when tested in accordance with TEST METHODS FOR PIPE, TUBLING AND FITTINGS given below.

CPVC Adhesives:

General—CPVC adhesives (other than CPVC solvent cement), shall qualify for use in CPVC socket-type joints by a rigorous simulated use testing program as further defined below. CPVC adhesives shall be tested in the largest size joint and in the exact type of joint for which they are intended; that is, 2-in. [50-mm] plastic-to-metal or 2-in. [50-mm] plastic-to-plastic.

Hydrostatic Sustained Pressure Strength—Socket-type CPVC adhesive joints, made and cured according to the adhesive manufacturer's recommended procedure, shall not separate or leak when tested in accordance with TEST METHODS FOR PIPE, TUBLING AND FITTINGS

Thermo-cycling—Socket-type CPVC adhesive joints, made and cured according to the adhesive manufacturer's recommended procedure, shall not separate or leak when

thermo-cycled 10000 times between the temperatures of 600F and 1800F [160C and 820C] in accordance with TEST METHODS FOR PIPE, TUBING AND FITTINGS given below.

4.0.1..6 Workmanship, Finish, and Appearance

The pipe shall be homogeneous throughout and essentially uniform in color, opacity, density, and other properties. The inside and outside surfaces shall be semi-matte or glossy in appearance (depending on the type of plastic) and free of chalking, sticky or tacky material. The surfaces shall be free of excessive bloom, that is slight bloom is acceptable. The pipe walls shall be free of cracks, holes, blisters, voids, foreign inclusion, or other defects which are visible to the naked eye and which may affect the wall integrity. Holes deliberately placed in perforated pipe are acceptable. Bloom or chalking may develop in pipe exposed to direct rays of the sun (ultraviolet radiant energy) for extended periods and consequently these requirements do not apply to pipe after extended exposure to direct rays of the sun.

Nominal Tube or Pipe Size	Outside Diameter, in. [mm]			Wall Thickness, in. [mm] ^C	
	Average	Tolerance on Average	Max Out-of-Round ^B	SDR 11	
				Min	Tolerance
3/8 Tube [10]	0.500 [12.7]	±0.003 [±0.08]	±0.003 [±0.08]	0.068 [1.73]	+0.020 [+0.51]
1/2 Tube [15]	0.625 [15.9]	±0.003 [±0.08]	±0.004 [±0.10]	0.068 [1.73]	+0.020 [+0.51]
3/4 Tube [20]	0.875 [22.2]	±0.003 [±0.08]	±0.005 [±0.13]	0.080 [2.03]	+0.020 [+0.51]
1 Tube [25]	1.125 [28.6]	±0.003 [±0.08]	±0.006 [±0.15]	0.102 [2.59]	+0.020 [+0.51]
1 1/4 Tube [32]	1.375 [34.9]	±0.003 [±0.08]	±0.007 [±0.18]	0.125 [3.18]	+0.020 [+0.51]
1 1/2 Tube [40]	1.625 [41.3]	±0.004 [±0.10]	±0.008 [±0.20]	0.148 [3.76]	+0.020 [+0.51]
2 Tube [50]	2.125 [54.0]	±0.004 [±0.10]	±0.010 [±0.25]	0.193 [4.90]	+0.023 [+0.58]
1 1/2 Pipe [40]	1.900 [48.6]	+0.006, -0.002 [+0.15, -0.05]	±0.008 [±0.20]	0.173 [4.39]	+0.021 [+0.53]
2 Pipe [50]	2.375 [60.7]	+0.006, -0.002 [+0.15, -0.05]	±0.010 [±0.25]	0.216 [5.49]	+0.026 [+0.66]

Table 2 Tapered Socket Dimensions for CPVC 41, SDR 11, Plastic Pipe and Tubing Fittings

Nominal Tube or Pipe Size	Average		Tolerance on Average		Max Out-of-Round ^C	Average		Tolerance on Average		Max Out-of-Round ^C
3/8 Tube	[10]	0.508 [12.90]	±0.003	[±0.08]	±0.003 [±0.08]	0.494	[12.55]	±0.003	[±0.08]	±0.003 [±0.08]
1/2 Tube	[15]	0.633 [16.08]	±0.003	[±0.08]	±0.004 [±0.10]	0.619	[15.72]	±0.003	[±0.08]	±0.004 [±0.10]
3/4 Tube	[20]	0.884 [22.45]	±0.003	[±0.08]	±0.005 [±0.13]	0.870	[22.10]	±0.003	[±0.08]	±0.005 [±0.13]
1 Tube	[25]	1.135 [28.83]	±0.003	[±0.08]	±0.006 [±0.15]	1.121	[28.47]	±0.003	[±0.08]	±0.006 [±0.15]
1 1/4 Tube	[32]	1.386 [35.20]	±0.003	[±0.08]	±0.007 [±0.18]	1.372	[34.85]	±0.003	[±0.08]	±0.007 [±0.18]
1 1/2 Tube	[40]	1.640 [41.66]	±0.004	[±0.10]	±0.008 [±0.20]	1.622	[41.20]	±0.004	[±0.10]	±0.008 [±0.20]
2 Tube	[50]	2.141 [54.38]	±0.004	[±0.10]	±0.010 [±0.25]	2.123	[53.92]	±0.004	[±0.10]	±0.010 [±0.25]
1 1/2 Pipe	[40]	1.918 [48.72]	±0.004	[±0.10]	±0.008 [±0.20]	1.900	[48.26]	±0.004	[±0.10]	±0.008 [±0.20]
2 Pipe	[50]	2.393 [60.78]	±0.004	[±0.10]	±0.010 [±0.25]	2.375	[60.33]	±0.004	[±0.10]	±0.010 [±0.25]

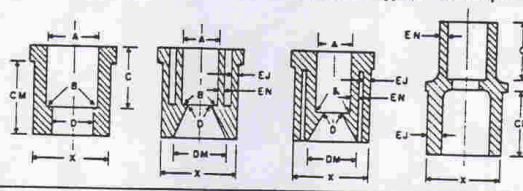
C Socket Length, min ^A , in. [mm]	D Inside Diameter, min ^D , in. [mm]	Wall Thickness, min ^D , in. [mm]			F	Entrance: min EW EX EZ, in. [mm]
		(E _s) Socket Entrance	(E _b) Socket Bottom			
0.500 [12.70]	0.364 [9.25]	0.068 [1.73]	0.102 [2.59]	0.128 [3.25]	0.034 [0.86]	
0.500 [12.70]	0.489 [12.42]	0.068 [1.73]	0.102 [2.59]	0.128 [3.25]	0.034 [0.86]	
0.700 [17.78]	0.715 [18.16]	0.080 [2.03]	0.102 [2.59]	0.128 [3.25]	0.034 [0.86]	
0.900 [22.86]	0.921 [23.39]	0.102 [2.59]	0.102 [2.59]	0.128 [3.25]	0.034 [0.86]	
1.100 [27.94]	1.125 [28.58]	0.125 [3.18]	0.125 [3.18]	0.156 [3.96]	0.042 [1.07]	
1.300 [33.02]	1.329 [33.76]	0.148 [3.76]	0.148 [3.76]	0.185 [4.70]	0.049 [1.24]	
1.700 [43.18]	1.739 [44.17]	0.193 [4.90]	0.193 [4.90]	0.241 [6.12]	0.064 [1.63]	
1.375 [34.92]	1.494 [37.95]	0.173 [4.39]	0.173 [4.39]	0.216 [5.49]	0.058 [1.47]	
1.500 [38.10]	1.933 [49.10]	0.216 [5.49]	0.216 [5.49]	0.270 [6.86]	0.072 [1.83]	

Table3 Minimum Dimensions from Center to End of socket (Laying Length) for CPVC 41,

SDR 11, Plastic Pipe and Tubing Fittings

Nominal Tube or Pipe Size		G Min ^o , in. [mm]	J Min ^o , in. [mm]	N Min ^o , in. [mm]
3/8 Tube	[10]	0.359 [9.12]	0.174 [4.42]	0.102 [2.59]
1/2 Tube	[15]	0.382 [9.70]	0.183 [4.65]	0.102 [2.59]
3/4 Tube	[20]	0.507 [12.88]	0.235 [5.97]	0.102 [2.59]
1 Tube	[25]	0.633 [16.08]	0.287 [7.29]	0.102 [2.59]
1 1/4 Tube	[32]	0.758 [19.25]	0.339 [8.61]	0.102 [2.59]
1 1/2 Tube	[40]	0.884 [22.45]	0.391 [9.93]	0.102 [2.59]
2 Tube	[50]	1.134 [28.83]	0.495 [12.57]	0.102 [2.59]
1 1/2 Pipe	[40]	1.022 [25.96]	0.448 [11.38]	0.102 [2.59]
2 Pipe	[50]	1.260 [32.00]	0.547 [13.89]	0.102 [2.59]

TABLE 4 Dimensions of Reducer Bushings for CPVC 41, SDR 11, Socket-Type, Plastic Pipe and Tubing Fittings^{A,B,C,D}



^A Tubing socket dimensions, A, B, and C, and tolerances on these dimensions shall be the same as in Table 2. The minimum length of the male end of the bushing or coupling, CM, shall be the same as C in Table 2, but in any case the male end shall bottom in the mating fitting. Minimum waterway dimensions, D and DM, shall be the same as D in Table 2. Minimum wall dimensions, EJ and EN, apply to the larger and smaller sizes joined respectively, and shall be the same as the corresponding values for E_s in Table 2.

^B The minimum socket wall thickness for reducing bushings shall be 102 in. [2.59 mm]. Reducing bushings may be cored if the socket wall thickness would otherwise exceed the total of EJ and EN calculated from the appropriate E_s values in Table 2. Where coring is used, the inner socket shall be reinforced from the outer wall by a minimum of three ribs extending the full depth of the coring.

^C The transition from D to DM may be straight, tapered as shown, or radiused, at the discretion of the manufacturer.

^D A taper on the male end of a bushing is optional. If a taper is used, it shall be a positive taper in the same direction as the taper in the socket. Whether a taper is used or not, all diameters X shall conform to the diameter and tolerance for the corresponding size of tubing shown in Table 1.

Table 5 Minimum Hydrostatic Sustained Pressure Requirements for CPVC 4120,SDR 11, Pipe, Tubing and Fitting Assemblies Tested in Either Water or Air Bath External Environment at 82 Degree

Test Condition	Test Duration	Hydrostatic Test Pressure	
		Water Bath	Air Bath
A	6 min	521 psi	551 psi
		[3 590 kPa]	[3 800 kPa]
B	4 h	364 psi	403 psi
		(2 510 kPa)	[2 780 kPa]

^A Test conditions were calculated from the following experimentally derived, 95 % confidence, rupture pressure versus time relationships for CPVC 41, SDR 11, pipe and tubing at 180°F [82°C]. Pressure, P, and time, t, are in psi and h respectively. The 50 % confidence relationships are given for information only.

log P = -0.085155 log t + 2.726805 (50 % confidence in air)
log P = -0.085155 log t + 2.656225 (95 % confidence in air)
log P = -0.097269 log t + 2.690464 (50 % confidence in water)
log P = -0.097269 log t + 2.619884 (95 % confidence in water)

Table 6 Minimum Hydrostatic Sustained Burst Strength Requirements for Nominal 50 mm CPVC Solvent Cemented Joints after 2 hour Drying at Test Temperature

Temperature	Burst Pressure
73.4°F [23°C]	400 psi [2 760 kPa]
180°F [82°C]	200 psi (1 380 kPa)

Table 7 Minimum Hydrostatic Pressure Requirements for CPVC Socket Type Adhesive Joint Assemblies Tested Either in the Water Bath or Air Bath External Environment at 82 Degree

Test Duration, h	Test Pressure	
	Water Bath	Air Bath
10 000	170 psi [1 170 kPa]	207 psi (1 430 kPa)

Table 8 Minimum suggested Drying Time for Drying Solvent Cemented fitting Assemblies in AIR at 82 Degree

Test Condition (from Table 5)	Suggested Drying Time at 180°F [82°C], h
A	4
B	16

4.0.1..7 Assembly

Solvent Cemented Joints:

Interference Fit—Components meeting the dimensional requirements of this specification are designed 10 having interference fit. Before making a cemented joint, ii is advisable to check for interference dry-fit. A good interference dry-fit exists when the pipe or tubing makes contact with the fitting socket wall between one third and two thirds of the way into the socket

Cutting— Pipe and tubing may be cut to length with tubing cutters. Tubing cutters with thin cutting wheels designed specially for plastic are recommended. Where tubing cutters are not available, a saw and meter box may be used. Burrs and ridges caused by handling or cutting must be removed before assembling a joint.

Solvent Cleaning—When recommended by the cement manufacturer, organic liquids can be used as a cleaning solvent for CPVC 41 components. These organic liquids should have a low solvation power for CPVC, to prevent mistaken use of the cleaning

solvent for a cement Uncemented joints with a good solvent THF for instance, will pass the usual cold water pressure check but are likely to fail later in hot water service.

Step-by-Step Assembly—Correct assembly consists of the following steps; (1) cut the pipe square; (2) remove burrs; (3) check for interference fit; (4) clean both pipe end and fitting socket with a recommended CPVC cleaner or by light sanding, or both; (5) apply a liberal coat of CPVC solvent cement to the pipe and apply a light coat of cement to the fitting socket; (6) assemble immediately by bottoming the pipe in the socket and rotating a quarter turn as the joint is assembled; and (7) remove excess cement from the joint. If a joint has been properly made, a small bead of cement will always appear at the juncture between the pipe of tubing and the fitting.

Adhesive Joints—Assemble according to the manufacturer's instructions paying particular attention to whether sanding of the pipe or tubing is recommended to eliminate the interference fit **Plastic-to-Metal Transitions**—Assemble in accordance with the manufacturer's instructions. Union and compression type transition fittings are likely to include ferrules or O-rings, or both, which form an essential part of the fitting assembly and should not be omitted. Plastic socket-to-male threaded adapters should be installed with a recommended thread sealant.

4.0.1..8 Installation

Storage and Handling—CPVC pipe, tubing, and fittings should be stored under cover to avoid unnecessary dirt accumulation and long-term exposure to sunlight Pipe and tubing should be stored with continuous support in straight, uncrossed bundles. Care should be used in handling to ensure that unnecessary abuse such as abrasion on concrete or crushing is avoided.

Installation Temperature—Extra care must be taken at temperatures of 40°F or lower and 110°F or higher. Always follow the manufacturer's installation instructions carefully.

Pressure Testing—CPVC piping systems made of ½ in. through 2-in. sizes in accordance with this specification, and utilizing a solvent cement requiring a primer or cleaner. can be pressure tested (using cold tap water only) at line pressure (150 psi maximum) after the solvent cement joints have cured for at least the following amount of time:

4.0.1..9 Test methods for pipe, Tubling and fittings

Sampling - A Sufficient quantity of Pipe, tubing or fittings, as agreed upon between the purchaser and the seller, shall be selected from each lot or shipment and tested In the case of no prior agreement, random samples selected by the testing laboratory* shall be deemed adequate.

Test Specimens—Not less than 50% of the test specimens required for any pressure test shall have at least a part of the marking in their central sections. The central section is that portion of pipe, which is at least one pipe diameter away from an end closure.

Flattening—Flatten three specimens of the pipe. 2 in. [50-mm] long, between parallel plates in a suitable press until the distance between the plates is 40 % of the outside diameter of the pipe or the walls of the pipe touch, whichever occurs first. The rate of loading shall be uniform and such that the compression is completed within 5 min. upon removal of the load, examine the specimens for evidence of splitting, cracking, or breaking.

4.0.1..10 Hydrostatic Sustained Pressure

Summary of Test Method—This test method describes a pass-fail test for CPVC 41 pipe, tubing, or fittings (tested as assemblies) subjected to a constant internal hydrostatic pressure for a predetermined period of time. Test conditions are based on known rupture pressure versus time relationships for standard CPVC 41 components (see footnote to Table 5). The external test environment may be either water or air. However, test pressures differ depending on the environment selected (see Table 5).

Apparatus:

Pressurizing System—A pressure source capable of rapidly and continuously applying a constant hydrostatic pressure, controlled to ± 10 psi [± 69 kPa] or better, to the test specimens.

Timing Device — Any clock capable of accuracy to within 1 % of the total test time.

Closure Fittings—Any suitable specimen closure that allows "free-end" mounting, is free of leaks, and will not contribute to end failures.

Sampling and Specimen Preparation:

Pipe and Tubing—Select at random specimens of at least seven times the nominal diameter in length, but in any case not shorter than 10 in. [250 mm]. Take three specimens for quality control testing. Take six specimens for qualification or referee testing..

Fittings—Select specimens at random. Take three specimens for quality control testing. Take six specimens for qualification or referee testing. Assemble the fittings, individually or collectively, using suitable lengths of CPVC 41 Pipe or tubing and CPVC solvent cement or CPVC adhesive. Use only pipe or tubing and solvent cement or adhesive meeting the requirements of this specification. Assemble the joints in accordance with the recommended procedure by the manufacturer. Allow solvent-cemented fitting assemblies to dry at elevated temperature, up to 180F [82C] maximum, in a forced-air oven until all joints are sufficiently strong to eliminate joint

failures during the test. Minimum suggested drying times are shown in Table 8. Cure assemblies prepared with CPVC adhesives according to the adhesive manufacturer's recommended procedure until the adhesive joints are sufficiently strong to eliminate joint failures during the test. In no case, however, should adhesive joints be cured at a temperature higher than 180F [82C].

Procedure—After curing all cemented or adhesive joints used, attach suitable end closures where necessary. Fill the specimen with water, making certain to avoid entrapment of air. Condition the test specimen at $180 \pm 1.8\text{F}$ [$82 \pm 1\text{C}$] for a minimum of 30 min if using a water bath, or 4h if using an air bath. Attach the specimen to the pressure source, and place it on test at $180 \pm 1.8\text{F}$ [$82 \pm 1\text{C}$] under the proper hydrostatic pressure selected from Table 5. Start the timer immediately. Hold the test pressure and temperature as close as possible to the specified values, but in any case to within ± 10 psi [± 69 kPa] and 1.8F [1C] respectively. At the end of the specified minimum time interval, isolate the specimen from the pressure source and check for any continuous loss of pressure resulting from transmission of water through the specimen. Any such continuous loss of pressure, resulting from bursting or weeping of the test specimens as defined in Test Method D 1598. Shall constitute failure. If joint leakage or joint separation has occurred, the test should be repeated using a longer joint drying or curing cycle.

4.0.1..11 Tests for Solvent Cement and Adhesive Joints

Test for Solvent Cement Joints:

Hydrostatic Burst Strength—Determine the minimum hydrostatic burst strength for CPVC solvent-cemented joints according to manufacturers recommendation. Except as herein specified. Test assemblies containing at least six nominal 2in. [50-mm] solvent cemented joints prepared for CPVC 41 pipe or tubing and fittings meeting the requirements of this specification. Assemble the joints in accordance with the recommended solvent cementing procedure as per manufacturers recommendation. After attaching end closures, fill the specimen assembly with water and condition in water at the test temperature for 2 h maximum. Then test immediately. Increase the internal pressure at a constant rate so as to reach the minimum burst requirement in 60 to 70 s. Leakage or separation at any of the joints tested at less than the minimum hydrostatic burst requirement specified in Table 6 shall constitute failure in this test.

Test for Adhesive Joints:

General— Prepare a test assembly containing at six adhesive joints of the largest nominal Diameter and the exact type (plastic-to-plastic, or plastic-to-metal) for which the adhesive is intended to qualify- Make and cure the adhesive joints in accordance with the adhesive manufacturer's recommended procedure, but in no case above 180F [82C. The CPVC 41 pipe or tubing and fittings used in the assembly shall meet the requirements of this specification.

Hydrostatic Sustained Pressure for Adhesive Joints

Any evidence of leaking or separation at the adhesive joint or adhesive-related bursting, weeping, or ballooning of the CPVC 41 components adjacent to the joint, shall constitute failure. Failure of any one of six joint specimens tested shall constitute failure in this test.

4.0.1.12 Wall flange

General

The item includes provision of wall caps on all walls and, columns, etc., wherever supply and disposal of pipes pierce through them.

Material

All the wall caps shall be chromium-plated brass snugly fitting. All the cap should have ISI certification mark.

Fixing

The cap shall be fixed in position as shown in the drawing or as directed on the pipe line with necessary fittings or as ordered by Engineer-in-charge receiving pipes shall be large enough to cover the punctures properly.

Mode of measurement

The measurement and payment shall be by numbers or as specified in the schedule of quantities.

Rate

The rate shall include all material cost including fixing in position, all lead, lift, labor and tools.

4.0.1.13 Floor traps

General

Floor traps shall be of C.I / prefabricated of the size required, of approved design incorporating a deep seal (6 cm. Minimum) and venting device unless otherwise indicated. The traps shall be supplied with at least iron cap with collar capable of receiving a screwed grating.

Mode of measurement

The measurement and payment shall be by numbers or as specified in the schedule of quantities.

Rate

The rate shall include all material cost including fixing in position, all lead, lift, labour and tools.

4.0.1.14 Fixing Water Meter and Stop Cock In G.I / CPVC pipe line

Materials

Pipe fittings as described in material section.

Cutting G.I./CPVC Pipe Line

The G.I./CPVC line shall be cut to the required length at the position where the meter and stop cock are required to be fixed. The ends of the pipe shall then be threaded. Unions shall be provided in the pipe assembly for fixing water meter.

Fixing Meter and Stop Cock

The meter and stop cock shall be fixed in position by means of connecting pipes, G.I. Jam nut and socket etc., the stop cock shall be fixed near the inlet of the water. The paper disc inserted in the ripples of the meter shall be removed and the meter installed exactly horizontal or vertical in the flow line in the direction shown by the arrow cast on the body of the meter.

Care shall be taken that the factory seal of the meter is not disturbed. Wherever the meter shall be fixed to a newly fitted pipe line, the pipe line shall have to be completely washed before fitting the meter. For this purpose a piece of pipe equal to the length of the meter shall be fitted in the proposed position of the meter in the new pipe line. The water shall be allowed to flow completely to wash the pipe line and then the meter installed as described above by replacing the connecting piece.

4.0.1.15 Insulation for hot water pipes

All hot water piping shall be insulated in the manner specified herein, before applying insulation, all pipe work and fittings shall be brushed and cleaned. Dust, dirt, mortar and oil shall be removed. For pipes running concealed in wall chases, they shall be provided with one coat of bitumastic paint followed by wrapping with PVC/UPVC tape tightly over the pipe.

The ends and overlap shall be tied with MS wire or Nylon rope. Asbestos rope/tape of thickness as mentioned below shall be wound tightly and evenly over the entire length of pipe including fittings and valves. The insulated pipe shall then be wrapped with two layers of polythene faced Hessain and tied with MS wire or nylon rope.

The thickness of insulation to be applied shall be as follows:

Pipe Size Insulation thickness

(Fibre glass insulation) Asbestos Rope/Tape for concealed piping

15 mm, 20 mm 25 mm 6 mm

25 mm 30 mm 8 mm

40 mm 40mm 10 mm

The thickness of insulation mentioned in the table above is exclusive of the thickness of plaster to be applied over the insulation material.

4.0.1.16 Inspection & test

General

After Installation and prior to testing, insulating or painting, inspect each run of each system for completion of joints, supports and accessory items.

During the progress of work, pressure test the various piping system including mains, risers, branches and fixtures as directed or as required to permit insulation, general construction and built in rough work to proceed.

Provide all apparatus and temporary work for tests. Take all due precautions to prevent damage to the building or its contents as a result of such tests. Pay for all such damage to the building or work of other trades caused by such tests. After testing remove all water.

Domestic water piping with water and test to 2 times the system working pressure but not less than 200 PSIG with no loss in pressure for a period 2 hours. Test includes all valve and vessels.

Testing the joints

After laying and jointing, the pipes and fittings shall be inspected under working conditions of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra cost. The pipes and fittings after they are laid shall be tested to hydraulic pressure of 6kg/cm². (double the designed working pressure whichever is more). The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock or water hammer. The draw off takes and stop cocks shall be then closed and specified hydraulic pressure shall be applied gradually. Pressure gauges at least 2 hrs. The pipes and fittings should be tested in section as the work of laying proceeds keeping the joints exposed for inspection during the testing.

Measurements

The length shall be measured in running meter correct to a cm. For the finished work, which shall include CPVC/UPVC pipes, fittings such as bends, tees, elbows, reducers, crosses, plugs, sockets, nipples and nuts, but exclude brass or gunmetal taps (cocks) valves, lead connection pipes and shower rose. The length shall be taken along the central line of the pipe fittings. All pipes and fittings shall be classified according to their diameter of the internal bore. The pipe shall be described as including all cuttings and wastage. In case of fittings of unequal bore, the largest bore shall be measured. Digging and refilling of trenches shall be measured separately or clubbed with main item as indicated in the BOQ.

For concealed piping the rates shall be inclusive of chasing of walls, fixing of pipes & fittings, making good the chases, etc., as indicated in the BOQ.

APPLICABLE CODE

A.	Pipes and Fittings	
1	IS : 1172	Code of basic requirements for water supply drainage and sanitation.
2	IS:1726	Specification for cast iron manhole covers and frames.
3	IS: 1742	Code of practice for building drainage.
4	IS : 2065	Code of practice for water supply in buildings.
5	IS : 3114	Code of practice for laying of cast iron pipes
6	IS : 5329	Code of practice for sanitary pipe work above ground for Buildings.
7	IS : 783	Part 3 Laying and jointing of UPVC pipes (first revision)
8	IS : 1239	Specification for MS or GI Pipes and fittings
9	IS : 1729	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
10	IS : 458	Concrete pipes (with and without reinforcements)
11	IS : 783	Code of practice for laying of concrete pipes.
12	IS : 4984	High density polyethylene pipes for potable water supplies, sewage and industrial effluents.
13	IS : 14735	Specification for Unplasticised Polyvinyl chloride (UPVC) injection moulded fittings for soil and waste discharge system for inside and outside buildings including ventilation and rain water system.
14	IS: 12592	Specification for precast concrete manual covers and frames (first revision).
15	IS : 13592	Specification for UPVC pipe for soil and waste water discharge system inside building including ventilation and rainwater system.
16	IS : 651	Salt Glazed stone ware pipes and fittings.
17	IS : 3006	Specification for chemically resistances salt glazed stone ware pipes and fittings (first revision).

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18	IS : 5455	Specification for cast iron steps for manhole.
19	IS :14961	Code of practice for ancillary structures in sewerage system : part-I manholes (1 st revision).
20	IS :4127	Code of practice for laying glazed stoneware pipes (first revision).
21	IS :779	Specification for water meter.
22	IS :15778	CPVC pipes and fittings.
23	ASTMF : 493	CPVC Solvent cement.
24	IS : 2104	Specification for water meter for boxes.
25	IS : 2373	Specification for water meter bulk type.
B.	Valves	
1	IS : 13095	Butterfly valves for general purposes.
2	IS : 778	Copper alloy gate, globe and check valves for water works purposes.
3	IS : 5312	Swing check type reflex valves for water works purposes.
4	IS : 129	Safety relief valves, spring loaded : Design.
5	IS: 780	Specification for sluice valves for water works purposes (50mm to 300mm size).
6	IS : 1703	Specification for ball valve (Horizontal Plunger Type) Including floats for water supply purpose.
C.	Pump & Vessels	
1	BIS: 1520	Specification for horizontal centrifugal pumps for clear cold fresh water.
2	BIS: 5600	Specification for sewage and drainage pumps
3	BIS: 8034	Specification for submersible pumps sets for clear, cold, fresh water.
4	BIS: 8418	Specification for horizontal centrifugal self priming pumps.
D.	Hot Water Boiler	
1	IS : 226	Indian Boilers Hot water system
2	BIS : 3059	Tubes in the Boiler
3	IS : 2062	M.S Plate in the Boilet

APPROVED MAKES

SL. NO	Details of Materials / Equipment	Manufacturer's Name
A	PIPES	
1	Floor Drain Fixture, Rain Water Outlets & Channel Gratings	Supreme / Prince / Finolex
2	S.S Grating for Floor Trap	Jaquar / Ess / Marc
3	Manhole covers and frames	Neco
4	UPVC Pipe	Supreme / Prince / Finolex
5	CPVC pipes	Astral / Supreem
D	PUMPS	
1	Pump and Accessories	Grundfos / C.R.I / Kishor / Kirloskar / Mather + Platt/Amstrong

5.0 SOIL & WASTE WATER PIPE LINES

5.0.1 Scope of work

Work under this section consists of supplying all labour, materials, equipment and appliances necessary and required to completely install soil, waste, vent pipes as indicated on the drawings and specification. Without restricting to the generality of the foregoing, the soil, waste and vent pipe system shall include the following:-

- a) Vertical and Horizontal Soil Waste pipes and fittings, joints, clamps and connections to fixtures.
- b) Connection of all pipes to sewer lines as shown on the drawings.
- c) Floor and urinal traps, cleanout plugs and inlet fittings.
- d) Testing of all pipe lines and all accessories as per Bureau of Indian Standards.

5.0.2 General requirements

Materials shall be of the approved make and quality specified. They shall conform to the respective Bureau of Indian Standards, British Standards Specifications, supported by Manufacturing Certificate and any other specification referred to herein.

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

Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, and in suspended ceilings.

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

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

5.0.3 Internal drainage works

Soils, waste, vent pipes and fittings

All soil, waste, vent pipes and fittings used within sunken floor areas in service floors or within plumbing shafts vertical run shall be PVC/ uPVC Pipes with washer jointed. The internal and external surfaces of pipes shall be smooth and clean, free from grooving and other defects. The end shall be designated by external diameter.

Installation methods:

Above ground installation

The uPVC pipes shall be laid and clamped to MS frames fixed above the surface of walls. Use of fittings with door and cleaning pipe may be made at suitable points to provide access for inspection and cleaning. Provisions shall be made for the effect of thermal movement by not gripping or restricting the pipe at supports between the anchors for suspended pipes. Generally the pipes shall be clamped at a spacing of 900 mm for horizontal run and 1200 mm for vertical run. It is essential that uPVC pipes shall be aligned the clamps are not fixed keeping the pipe plumb. The pipe aligned properly before fixing them.

Concealed installation

For concealing the drain lines in sunken floors, pipes shall be laid to proper slope and shall be aligned first proper P.C.C / brick masonry supports shall be provided near the joints and at regular intervals. Sharp edged objects shall be avoided while filling the sunken portions. All concealed lines shall be tested for leakage before concealing the system.

Underground installation

For laying uPVC Pipes in trenches, trench width should not be less than pipe diameter plus 300 mm, while trench depth should be about 600 to 1000 mm depending upon the size of the pipe and slope as required. Care should be taken to avoid dirt entering the joints. The trench bottom shall be carefully examined for the presence of hard objects such as flints, rock projection or tree roots, etc., Pipes shall be bedded in sand or soft soil free from rock and gravel. Back filling shall be with fine river sand or soft soil and should be carried out to a height of 150 mm above the pipe. Pipes shall not be painted Testing of the lines shall be done before filling back the trench.

5.0.4 Jointing–UPVC Pipes

Solvent welded joints

This technique is used with spigot and socket type joints, in which the socket is made specially to form a close fit on the pipe end and with injection moulded / fabricated fittings.

Solvent cement of Supreme Industries Ltd., or Equivalent make shall be used as per the recommendation of the manufacturers. The dust, oil, water grease, etc, should be wiped out with dry cloth from the surface to be coated with solvent cement. Before applying solvent cement, the pipes and fittings should set and laid as per the layout and the length of insertion of pipe end into the sockets should be marked. The pipes and fittings are then dismantled and joints effected progressively. The coating of solvent cement shall be applied evenly on the inside of the fitting for full length of insertion and then on the outside of the pipe end upto the marked line and the pipe twisted to a quarter of a turn to spread the cement evenly at the same time ensuring the pipe, pushed home fully into the socket. The pipe should be pushed into the fitting

socket and held for one to two minutes as otherwise the pipes come out of the fitting due to slipperly quality of cement and the tapered inside bore of the fitting. The surplus cement on the pipe surfaces shall be wiped out. In most of the cases the pipe inserted should be upto the marked line and in no case shall be less than 2/5 of the diameter of the pipe and upto marked line.

When the joints is made, the remaining cement on the pipe surfaces shall be wiped off immediately without fail as the continued action of solvent cement

Storage of UPVC pipes:

To avoid any possibility of damage uPVC Pipes and fittings, a few points should be observed.

- Pipes and fittings should not be kept on sharp objects.
- Pipes and fittings shall be lifted and not dragged.
- Fittings should be stored in cartons or bags.
- Pipes should be stacked on even surface, the stacking height not exceeding 1.5 mts. if they have to be stored for a long period.
- Rubber rings should be kept tension free
- Lubricants and solvent cement should be stored in a cool place away from direct sunlight.

5.0.5 Clean outs

- Provide clean outs at the base of all soil, waste and leader stacks and all changes in direction of horizontal piping, wherever no manholes are present. Distance between clean outs on horizontal runs shall be minimum 15 M on centers.
- Clean out fittings in vertical stacks shall consist of tapped tees capable for receiving a rough brass raised head clean out plug.
- When clean outs occur in floor, furnish and install fittings with clamping collar device where required. Clean out shall be of following type – cast iron, with aerated cut – off sections.
- All clean out plugs shall be brass and lubricated with graphite before installation
- Clean out fittings to exterior grade shall consist of clean out plug, cast iron double flanged housing and cast iron vandal-proof cover.
- Clean outs occurring in cast iron soil pipe above floor at change in direction of pipe run and at end of horizontal runs shall have cast iron ferrule for caulk connection and fitted with a straight threaded, tapered bronze plug with raised head.

Installation

All materials shall be new and installed in a first class manner.

- All drainage piping, unless otherwise indicated, shall be pitched at a minimum rate of 10 MM / 1M in direction flow. Branch connections to stacks or main drains shall not be made in a manner which will permit back-flow.

- Any main vent line, regard less of size off-setting horizontally shall be made of galvanized steel pipe and back steel pattern fittings unless otherwise noted from point of offset and up through roof.

Nipples

Any piece of pipe 200 MM in length and less shall be considered a nipple.

All nipples shall be used unless otherwise directed.

Plugged outlets

Plugged outlets shall be left in drainage piping for future fixtures, where indicated on the drawings.

5.0.6 Cleaning, Operation & Tests

- Plumbing equipment fixtures, piping, etc., shall be free of stamping, marking (except those required by codes) iron cutting and other foreign materials.
- Hot, Cold and drinking water system shall be cleaned thoroughly, filled and flushed with water.
- Test all plumbing systems in the presence of the Engineer Incharge / Employee Representative at Site / Consultants as herein specified. Provide all equipment, materials and labour necessary for inspection and tests and repair all work, not passing the tests. After repairs are made, repeat test until units / systems is found satisfactory, to the above authorities. Carry out tests prior to concealing, insulating or back filling over any piping. No exceptions will be made.

Water test

Test entire system or sections of closing all openings except the highest opening and filling system with water to the point of overflow. If the system is tested in sections, plug each opening except the highest opening of the section filled with water. Keep the water in system or in portion under test for at least 45 minutes before inspection starts with test pressure / head lasting for two hours. The system must be tight at all joint.

Test all down, spouts or rain headers and their branches within the building by water as described for the above soil, waste and vent system

Final test

After fixtures are set, test the system with smoke test as follows:

Smoke test

Fill traps with water, then introduce into system a pungent thick smoke produced by one or more smoke machines. When smoke appears stacks on the roof, plug stacks and allow pressure of 1-inch water column to build up in systems. The system shall be tight at all joints.

Test all down spouts or rain headers and their branches within the building by water as described for the above soil, waste and vent system.

All water piping

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- Hydro-static test 7.5 kg / cm² or twice the working pressure whichever is higher. Without drop in pressure as required.
- All tests on below ground lines shall be continued until back fill on such lines is completed to disclose any damages caused by back-filling
- All systems shall be tested in sections as required to expedite the work of other trades and meet construction schedules and final test on completion.
- On completion of the works, the following tests shall be performed to the satisfaction of the HLL Engineer-in-charge before issue of virtual completion certificate, if so required.
 - a. Smoke Test
 - b. Hydraulic Test
 - c. Performance Test for fixtures
 - d. Tests for anti-siphonage system
 - e. Pump rating and output
 - f. Inspection of all units and fixtures.

The Contractor shall arrange for similar tests during the progress of works to ensure that there are no defects in material / workmanship in portions of work to be concealed or embedded under the floor or walls or in ceiling and get this approved by the Consultants. The under floor pipe works shall not be closed without the approval of Consultants.

APPLICABLE CODE

A.	Pipes and Fittings	
	IS: 1742	Code of practice for building drainage.
	IS : 3114	Code of practice for laying of cast iron pipes
	IS : 5329	Code of practice for sanitary pipe work above ground for Buildings.
	IS : 783	Part 3 Laying and jointing of UPVC pipes (first revision)
	IS : 1729	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
	IS : 458	Concrete pipes (with and without reinforcements)
	IS : 783	Code of practice for laying of concrete pipes.
	IS : 14735	Specification for Unplasticised Polyvinyl chloride

		(UPVC) injection moulded fittings for soil and waste discharge system for inside and outside buildings including ventilation and rain water system.
	IS: 12592	Specification for precast concrete manual covers and frames (first revision).
	IS : 13592	Specification for UPVC pipe for soil and waste water discharge system inside building including ventilation and rainwater system.
	IS : 651	Salt Glazed stone ware pipes and fittings.
	IS : 3006	Specification for chemically resistances salt glazed stone ware pipes and fittings (first revision).

APPROVED MAKES

SL.NO	Details of Materials / Equipment	Manufacturer's Name
A	PIPES	
1	Floor Drain Fixture, Rain Water Outlets & Channel Gratings	Supreme / Prince / Finolex
2	S.S Grating for Floor Trap	Jaquar / Ess / Marc
3	UPVC Pipe	Supreme / Prince / Finolex

5.0.7 Miscellaneous items

Supports, Pedestals and base for inspection chambers, gully traps and pipes shall be in 1:2:4 cement concrete mix.

- Pipe sleeves and inserts, etc., through RCC walls either external or internal shall be of C.I. or M.S provided with water bar flange.
- During installation open ends of pipes shall be plugged with wood cut into required shae or gunny bags and to be maintained free from dirt.
- Space between pipe and sleeve packed with hemp and chalk water tight with lead.
- Space between pipe or pipe covering and sleeve with a non combustible, permanently plastic, water proof, non-staining compound, leaving a finish smooth

appearance or pack with mineral wool or fiber glass within 15 mm of both wall faces and provide caulking compound as per above, on floors provide caulking compound on inside faces only.

- The size of branch waste pipes for different fittings shall be generally as follows:

Wash Basin	-	40 mm dia uPVC
Sink	-	50 dia uPVC waste pipe.
- W.C. pan connectors shall be to suit the requirements as per drawing, with 75 dia. Vent horn for connection to the anti-syphonage pipe with pan connector.
- The pipe connection to the sewage or storm water collection chambers shall be perfectly water tight.
- The floor traps for toilet blocks shall be specially made to suit the toilet configuration. The trap shall be of uPVC with one inlet and one outlet SS grating with suitable flashing shall be provided. The trap shall be generally of size 100 x 75.

Supports

General

Provide proper solid angle iron section, supports for all pipe runs in the vertical ducts. For attachment in concrete, use “Dash” fasteners or Anchor plug type inserts or equivalent. Support angles to be fixed at 1500 mm C/C maximum.

Cuttings, patching, repairing & making good

Cutting, Patching and repairing required for the proper installation and completion of the work specified in each division, including chasing, plastering, masonry work, concrete work, etc., and making good shall be carried out by the Contractor wherever required. Any damages to water-proofed location should not be patched up, without rectification by the water-proofing agency (specialist contractor) to ensure his guarantee. Repair of water proofing shall be born by the Sanitary Contractor.

Equipment protection

- Keep all pipe and conduit openings closed by means of plugs or caps to prevent the entrance of foreign matter. Protect all piping, conduit, fixtures, equipment or apparatus. Any such items damaged prior to final completion or work shall be restored to its original condition or replaced at no expense to the Owner.
- **Accessibility:** The installation of valves, thermometers, clean out fittings and other indicating equipment or specialties requiring frequent reading, adjustment, inspections, repairs, removal or replacement, shall be conveniently and accessibly located with reference to the finished building. Thermometers and gauges shall be

installed so as to be easily read from the floor. For floor clean outs minimum distance of 600 mm shall be available from any wall.

Disinfection of piping system and storage tanks

Before commissioning the water supply system, the Contractor shall arrange to disinfect the entire system as described in the succeeding paragraph. The filtered water storage tanks and pipe shall first be filled with water and thoroughly flushed out. The storage tanks shall be then filled with water again and disinfecting chemical containing chlorine added gradually, while tanks are being filled to ensure thorough mixing. Sufficient chemicals shall be used to give the water a dose of 50 parts of chlorine to one million parts of water. If ordinary bleaching powder is mixed with water to a creamy consistency before being added to the water in the storage tank. If a proprietary brand of chemical is used, the proportions shall be as specified by the manufacturer. When the storage tank is full, the supply shall be stopped and all the taps on the distributing pipes opened successively, working progressively from storage tank. Each tap shall be closed when the water discharge begins to smell of chlorine. The storage tank shall then be filled up with water from supply pipe and added with more disinfecting chemical in the recommended proportion. The storage tank and pipe shall then remain charged at least for three hours. Finally, the tank and pipes shall be thoroughly flushed out before any water is used domestic purpose.

5.0.8 Gully trap chambers

Stoneware gully traps of specified size shall be provided as per IS 651. It shall be fixed on 15 cm. thick and 70 cm square 1:4:8 cement concrete bedding and the gully outlet shall be jointed similarly to the jointing of stoneware pipes. Construction gully trap chamber shall be as indicated in the drawing. The corners and bottom of the chamber shall be rounded off so as to slope towards the grating and the bottom of the chamber shall not be less than 230 mm. In addition to 150mm x 150mm CI grating, the chamber shall have a CI frame cover (300mm x 300 mm). It shall then be placed on top of the brick masonry.

5.0.9 Urinal Trap

The urinal trap shall be double outlet type. The traps shall be deep seal type with an effective seal of minimum 75mm. The outlet from urinals after the trap shall be directly discharged to the floor trap. The floor trap shall be provided with 150 x 150mm SS or cost bronze chrome plated frame with screw type cover for airtight fitting. Frame and cover shall be of a make and model approved by the Construction Managers / Professional Team.

6.0 EXTERNAL PLUMBING AND SANITARY WORKS.

6.0.1 GENERAL INSTRUCTIONS:

System Description.

Plumbing & Sanitary Works.

The plumbing system is designed based on National Building Code and Local Bylaws.

Based on the above standards the entire plumbing system is designed keeping in the consideration the adequate water and pressure available at all the user points.

The source of water supply is from existing Bore well, Municipal (if available) and bought out water supply.

The reticulation of water supply system shall be with a gravity supply system. A constant pressure of 0.7 Kg. / Sq.cm at remote point of use.

6.0.2 Applicable Codes and Standards

The installation shall conform in all respects to the following standards in general:

IS 7558 – 1974	:	Code of practice for domestic hot water installation
IS 5329 – 1983	:	Code of practice for sanitary pipe work above ground for buildings.
Is 2064 – 1973	:	Code of practice for selection, installation and maintenance of sanitary appliances
IS 1200 (Part 16)	:	Method of measurement of laying of water and sewer lines including appurtenant
IS 1200 (Part 19)	:	Method of measurement of Water supply, plumbing and drains.
IS 783 – 1959	:	Code of practice for laying of concrete pipes
IS 13592 – 1992	:	Specification for unplasticized PVC pipes for soil and waste discharge system inside building including ventilation and rainwater.
IS 2527 – 1984	:	Code of practice for fixing rainwater gutters and down pipes for roof drainage.
IS 6784 – 1984	:	Method of performance testing of water meters (Domestic type).
IS 12235 (Parts 1 to 11)	:	Methods of test for unplasticized PVC pipes for portable water supplies.

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IS 458 – 1988	:	Specification for pre-cast concrete pipes (with or without reinforcement)
IS 771 – (Part 3 to 6)	:	Specific requirements for urinals
IS 2548 (Part 1&2)	:	Specification for plastic seats and covers for water closets.
IS 1703 – 1977	:	Specification for ball valves (Horizontal plunger type) including floats for water supply purposes.
IS 4038 – 1979	:	Specification for foot valves for water works purposes.
IS 1172 – 1983	:	Code of basic requirements for water supply, drainage & sanitation (revised).
IS 1239 – 1990 (Part I)	:	Specifications for mild steel tube, tubular and other steel pipe fittings.
IS 1239 – 1992 (Part II)	:	Specifications for mild steel tube, tubular and other steel pipe fittings.
IS 1726 – 1991	:	Code for cast iron manhole frame and cover (Third revision).
IS 1742 – 1983	:	Code of practice for building drainage. (Second revision)
IS 2064 – 1973	:	Code of practice for selection, installation and maintenance of sanitary appliances.
IS 2065 – 1983	:	Code of practice for water supply to buildings.
IS 4111 – 1986	:	Code of practice for Ancillary structures in sewerage system
BS 4515	:	Specification for unplasticized PVC pipe fittings.
IS 4985 – 1988	:	Specification for unplasticized PVC pipes for portable water supplies (second revision)
IS 732 & IS 2274 – 1963	:	Indian Standard code of practice for electrical wiring & installation.
IS 771	:	Part I to Part VII-Specification for vitreous china sanitary ware.
IS 778	:	Specification for gunmetal gate, globe and check valves for water, steam and oil only.
IS 800	:	Structural Steel Works

IS 1726	:	Specification for cast iron manhole covers and frames intended for use in drainage work.
IS 1239	:	Specification of GI class 'B' Pipes & fittings for external water supply pipes
IS 4984	:	High density polyethylene pipes for potable water supplies, sewage and industrial effluent (third revision).
IS 7634 (Part II)	:	Laying and jointing polyethylene (PE) pipes
IS 8008 (Part I to VII)	:	Injection moulded HDPE fittings for potable water supplies.
IS 8360 (Part I to III)	:	Fabricated high density polyethylene (HDPE) fitting for potable water suppliers.

National building Code for Water Supply, drainage and Sanitation. Part IX Plumbing services section 1 and 2.

The installation shall also be in conformity with the bylaws and requirements of the local authority in so far as these become applicable to the installation. Wherever this specification calls for, a higher standard of materials and/or workmanship than those required by any of the above regulations and standards, then this specification shall take precedence over the said regulations and standards.

Wherever the specifications and drawings require something that may conflict with the regulations, the regulations shall govern. This shall be referred to the Construction Managers / Professional Team for approval.

6.0.3 Drawings, Specifications and Deviations.

The drawings and specifications lay down minimum standards of equipment and workmanship. Should the tenderer wish to depart from the provisions of the specifications and drawings either on account of manufacturing practice or for any other reasons, he should clearly draw attention in his tender to the proposed points of departures and submit such complete information. Drawings and specifications will enable the merits of the deviations to be fully appreciated. In the absence of any such deviation list, it will be deemed that the tenderer is fully satisfied with the intents of the specifications and the drawings and their compliance with the statutory provisions and local codes. All deviations or departures not brought out to the notice shall be disregarded.

6.0.4 Tools and Spare Parts.

All the tools and tackles, scaffolding and staging required for erection and assembly of the installation covered by the contract shall be obtained by the contractor himself. All other material such as foundation bolts; nuts etc, required for the installation of the plant shall be supplied and included in the contract.

Tenderer shall include spares recommended by him for two years operation commencing from the Date of Issue of the Certificate of Substantial Completion] for each type of equipment covered by the specification.

6.0.5 Shop Drawing, Inspection and Testing.

6.0.6 Working and construction drawings.

The contractor shall prepare shop drawings and all work shall be according to approved working drawings. Shop drawings shall give all dimensions and shall incorporate the requirements of the clients/Construction Managers / Professional Team. Approval of drawings does not relieve the contractor of his responsibility to meet the intents of the specifications. All such drawings for approval shall be submitted in 6 copies to the Construction Managers / Professional Team. In addition, the contractor shall submit manufacturer's details and get them approved before ordering. This has to be done whether the materials / equipment are one of the approved makes or not.

6.0.7 Testing and Inspection.

The contractor shall carry out tests on different equipment and system in total as specified in various sections of the tender in the presence of the Construction Managers / Professional Team in order to enable them to determine whether the plant, equipment and installation in general comply with the specifications. All equipment shall be tested after carrying out the necessary adjustments and balancing to establish equipment ratings and all other design conditions. The test data shall be submitted in Acceptance Test Form.

6.0.8 Calibration of instruments and meters.

Instruments required for testing shall be furnished by the contractor for testing with initial requirements of all consumables. All the instruments, meters etc to be used at site and on the system shall have a valid calibration certificate issued by the competent authority. The contractor shall maintain and make available all such calibration certificates.

6.0.9 Handing over requirements.

The plant shall be handed over after satisfactory testing along with 6 sets of the following documents along with CDs (Soft copy).

1. Detailed equipment data in the approved proforma
2. Manufacture's maintenance and operating instructions manuals
3. Set of as built drawings, layouts, piping, ducting, cable routing, cable schedules etc
4. Approved test readings of all equipment and installations
5. Inspection certificates
6. Certificates of approval from statutory or Local Authorities for the operation and maintenance of the installations, wherever such approval or certification is required. This shall include Application filed along with enclosures and receipts of fees paid and deposits made.
7. Warranty / guaranty certificate for all equipments
8. List of recommended spares together with list of suppliers and their contact details.

9. Certificate from the contractor that he has cleared the site of all debris and litter caused by him. However, contractor has also to periodically clear the site from all the debris, which is generated from his part of scope.
10. Undertaking that all the materials supplied by him at site are fully tax paid and shall produce all documentation for satisfaction of the Construction Managers / Professional Team or taxation authorities.

Submission of the above documentation shall form a precondition for final acceptance of the plant and installation and final payments.

6.0.10 Statutory approvals inspection.

The contractor shall be fully responsible for meeting all the statutory obligations and local inspectorates wherever applicable to the works carried out by them. The contractor should prepare all working drawings and obtain approval of competent authorities and also have the equipment and installation inspected and got approved.

All obtaining approval fee and deposit towards statutory approval and inspection paid against demand in writing from the appropriate authority will be reimbursed on submission of original receipts. All other expenses for submission and approval of the various and relevant statutory / bodies shall be embodied in the tender prices.

GENERAL PROVISIONS

7.0 Scope.

The General character and the scope of work to be carried out under this section is illustrated in the specifications and drawings attached herewith. The contractor shall carry out and complete the said work under this contract in every respect in conformity with the rules and regulations of the local authority. The Contractor shall supply all labour, materials, appliances, tools and equipment necessary for the work for plumbing services installation including testing, commissioning and maintenance as specified herein, and as per the relevant Bureau of Indian Standards (BIS), British Standards codes, and local regalities. This also includes any material, appliances and equipment not specifically mentioned herein or noted on the drawings as being supplied or installed which are necessary and customary to make a complete installation properly connected and in working order.

Carryout all incidental works connected with plumbing services installation such as excavation of trenches and back filling, cutting and chasing in concrete and brick and making good, cutting/drilling holes through walls, floors, and grouting for fixing of fixtures/equipment and so forth.

Furnish and install complete workable plumbing services installation as shown on the drawings and described in this specification and as per the latest Bureau of Indian Standards (BIS), British Standards (BS) specifications including all that which is necessary to all the buildings, internally and externally including MS

angle Iron brackets, Hi-tech pipe supports required for pipe fixing on walls and ceiling.

Furnish and installation of site utilities such as the sewerage and sewerage appurtenances internally as well as around the building and up to the sewage treatment plant as indicated in the drawing.

Supplying / storing / installation of sanitary wares and accessories shall be plumbing contractor's scope of work.

Co-operating, co-ordinating and interfacing with other trade contractors in putting the installation in place. Any work done without regard or consultation with other trade contractors, shall be removed by the contractor without additional cost, to permit proper installation of all other work, as desired by the Construction Managers / Professional Team.

Repair all damage done to the premises as a result of this installation and remove all debris left by those engaged for this installation to the satisfaction of Construction Managers / Professional Team.

Cleaning of all plumbing and sanitary fixtures, testing and proving the satisfactory performance of all fixtures at the time the buildings are handed over to the Construction Managers / Professional Team.

It is the responsibility of the contractor to take care of all fittings and fixtures fitted until the time of final handing over to the Construction Managers.

Painting of all concealed and exposed pipes shall be as specified.

Taking full responsibility for getting the entire installation duly approved by the authorities concerned and for all expenses in connection with the same. Taking full responsibility of obtaining and delivering the certificate of final inspection and approval by the concerned authorities to Construction Managers / Professional Team.

7.0.1 Licensed plumber.

All work performed by the contractor shall be through licensed plumbing supervisor possessing a valid plumbing contractors license employing Engineers, Technicians, Foremen, Plumbers, Masons, Helpers, etc., as required.

7.0.2 Fees, permits and notices.

Contractor shall comply with all bye-laws and regulations of local and other statutory authorities having jurisdiction over the works and shall be responsible for the payment of all fees and other charges and giving and receiving of all necessary notices. Contractor shall keep the Construction Managers/ Professional Team timely informed about regulations and requirements of statutory Authorities and shall obtain the final certificates of inspection and approval from the authorities.

7.0.3 Specifications and drawings.

The specifications and drawings shall be considered as part of this contract and any work or materials shown on the drawings and not called for in the specifications or vice versa shall be executed as if specifically called for in both.

The tender drawings indicate the extent and general arrangement of the fixtures, drainage system, etc. The drawings indicate the points of supply and termination of work shall be installed as indicated in the drawings. However, any changes found essential to co-ordinate with this work and other trades shall be made without any additional cost. The drawings and specifications are meant for the assistance and guidance of the contractor, and exact location, distance and levels will be governed by the individual building and site conditions. Therefore, approval of the Construction Managers / Professional Team shall be obtained before commencement of work.

Exact routing and sizes of all piping on all the floors and the vertical stacks.

Ground and invert levels of all drainage pipes together with location of all manholes and connections up to outfall.

Run of all water supply lines with diameters, location of control valves, access panels.

Location of all the mechanical equipments with layout and piping connections.

Contractor shall provide six sets of catalogues, 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.

All "Warranty Cards" given by the manufacturers shall be handed over to the Construction Managers / Professional Team.

7.0.4 Manufacturers instructions.

Where manufacturers have furnished specific instructions relating to the materials used in this job and methods of construction that are not specifically mentioned in these documents, such instructions shall be followed in all cases. The contractor shall also furnish six sets of the detailed instruction, operating and maintenance manuals including detailed completion drawings and Fire Safety Plans on a bound copy to approved scale. Further it is the responsibility of the contractor to train the Employer's / Employer's Authorized Representatives' personnel in the operation and maintenance of the system.

7.0.5 Materials.

Materials shall be of approved make and quality specified. They shall conform to the respective Bureau of Indian Standards, British Standards Specifications and supported by Manufacturing Certificate / test certificate.

All materials shall be used as per the list of approved makes; however the final choice shall always remain with the Construction Managers / professional team.

In any case of non-availability of materials in metric sizes, the nearest size of FPS units shall be provided with prior approval of the Construction Managers / Professional Team at no extra cost.

7.0.6 Guarantee.

The contractor shall guarantee both the material and workmanship of first class quality corresponding to standard engineering practice for a period of 12 months from the date of issue of completion substantial. Any defective materials / workmanship shall be rejected and the contractor has to rectify / replace at his own cost. The Guarantee Certificates of the materials supplied shall be handed over to the Construction Managers / Professional Team.

SITE UTILITIES

7.0.7 Utilities trenches.

The specification establishes general criteria for efficient implementation of site utilities.

The following site utilities shall be placed as per the planning and as per specifications.

- a. Storm water drainage & Rain water harvesting
- b. Domestic sewerage
- c. External water supply system
- d. Fire protection system
- e. Other mechanical systems
- f. Electrical cables.

7.0.8 Alignment and grade.

Drains are to be laid to correct alignment & grade shown in the drawings but subject to such modifications as necessary to meet the requirements of the works. No deviations from the lines, depths of cutting or gradients of sewers shown in the plans and sections shall be permitted except by the express direction in writing of the Construction Managers / Professional Team. The pipe shall be laid to slope with the socket and spigot ends on higher and lower side respectively.

7.0.9 Opening out trenches.

In excavating the trenches, the road metalling, pavement kerbing, etc., are to be placed on one side and preserved for reinstatement and the trench or other excavation shall be filled up and laid back to original condition at no extra cost. Before any road metal is replaced, it shall be carefully shifted. The surface of all trenches and holes shall be restored and maintained to the satisfaction of the Construction Managers / Professional Team. The contractor shall not cut or break down any live fence or trees in the line of the proposed works but shall tunnel under them unless the Construction Managers orders the contrary. The contractor shall scrub and clear the surface over the trenches and other excavations of all stumps, roots and other encumbrances affecting execution of work and shall remove the same from the site as per the directions of the Construction Managers.

7.0.10 Excavation to be taken to proper depth.

Trenches shall be excavated in all conditions of soil and to such a depth that the sewers / or other pipes shall rest as described in the several clauses relating thereto and so that the inverts may be at the levels given on the section. Should the contractor excavate the trench to a greater depth than is required the extra depth shall have to be filled up with concrete at the contractor's own cost to the requirements and satisfaction of the Construction Managers / Professional Team.

7.0.11 Refilling.

After the sewer or other piping work has been laid and proved to be water-tight, the trench or other excavation shall be refilled. Utmost care shall be taken in doing this so that no damage is caused to the sewer and other permanent works. Filling in the trenches up to 50cms. above the crown of the sewer shall

consist of the finest selected materials placed carefully and consolidated. After this has been laid, the trench and other excavation shall be refilled carefully in 15cms. layers with material taken from the excavation, each layer being watered and consolidated.

7.0.12 Back filling of trench (IS: 12288 – 1987).

For the purpose of back filling, the depth of the trench shall be considered as divided into the following three zones from the bottom of the trench of its top, for the purpose of refill materials to be used.

ZONE A

From bottom level of trench to the level of the center line of the pipe. .

ZONE B

From the level of the center line of the pipe to a level 30 cm above the top of the pipe, and

ZONE C

From a level 30 cm above the top of the pipe to the top of the trench

7.0.13 Back fill materials.

All backfill materials shall be free from cinders, ashes, slag, refuse, rubbish, vegetable or organic materials, lumpy or frozen materials boulder, rocks or stone or other materials which in the opinion of the Construction Managers / Professional Team, is unsuitable for deleterious. Fine excavated earth, which shall pass through a sieve of aperture size 20mm can be used for filling in zones A & B. However, material containing stones up to 20mm as their greatest dimension may be used in zone C only unless otherwise specified by the Construction Managers / Professional Team. Where excavated material in considered by the Construction Managers / Professional Team not suitable for back filling, clean river sand shall be used for the same.

7.0.14 Back fill sand.

River sand used for back fill shall be natural sand complying with Para 1.6 graded from fine to coarse. The total weight of clay in it shall not exceed 10 percent. All material shall pass through a sieve of aperture size 20mm (IS-2405-1980) and not more than 5 percent shall remain on IS sieve of aperture size 6.30mm.

7.0.15 Back-fill gravel.

Gravel used for back fill shall be natural gravel and having durable particles graded from fine to coarse in a reasonably uniform combination with no boulders or stone larger than 50mm in size. It shall not contain excessive amount of loam and clay and not more than 15 percent shall remain on a sieve of aperture size 75 micron.

7.0.16 Back filling in zone A shall be done by hand with fine excavated material or river sand, fine gravel or other approved materials placed in layers of 8cm and compacted by tamping. The back filling material shall be deposited in the trench for its full width of each side of the pipe, fittings and appurtenances simultaneously.

7.0.17 Back-filling in zone B using fine excavated material shall be done by hand or approved mechanical methods using the fine excavated material special care being taken to tamping and to avoid injuring or moving the pipe. If excavated material is not suitable, the type of back-fill material to be prescribed by the Construction Managers / Professional Team to suite individual locations.

7.0.18 Back filling in zone C shall be done by hand or approved mechanical methods and well compacted. Excavated earth having stones of size not exceeding 20mm can be used for zone C. If the excavated earth unsuitable for back fill the filling material shall be specified by the Construction Managers / Professional Team.

7.1.6.30 Backfill with excavated materials.

Where the excavation is made through permanent pavements, curbs, paved footpaths, or where such structures are undercut by the excavation, the entire back fill to the sub-grade of the structures shall be made with sand or cement concrete in accordance with Para 1.6. The method of placing and consolidating the back fill material shall be prescribed by the Construction Managers / Professional Team.

7.0.19 Concrete slabs over pipes.

When pipes are laid under roads and pavements subjected to heavy traffic loads the trenches may be covered with reinforced concrete slabs of suitable dimension, supported on edges to relieve the load on pipes to the adjoining earth.

7.0.20 Site cleaning on completion of work.

All surplus pipes and fittings, valves, etc., and all tools and temporary structures shall be removed from the site as directed by the Construction Managers / Professional Team. All dirt rubbish and excess earth from the excavation shall be removed and transported and disposed at a suitable place as directed by Construction Managers / Professional Team and the construction site left clean to the satisfaction of the Construction Managers / Professional Team.

7.0.21 Contractor shall restore settlement and damages.

The Contractor shall at his own cost make good promptly, during the whole period that the works are in hand, any settlement that may occur on the surfaces of roads, beams, footpaths, gardens, open spaces, etc. whether public or private caused by his trenches or his other excavations and he shall be liable for any accidents caused thereby. He also shall, at his own expense and charge, repair and make good any damage done to the buildings and other properties.

7.0.22 Disposal of surplus.

The Contractor shall at his own cost dispose within the site or as directed all surplus excavated materials not required to be used in the work.

7.0.23 Timbering.

The Contractor shall at all times support efficiently and effectively the sides of trenches and other excavations by finest selected timbering, piling, sheeting

material, etc., at his own cost. The trenches shall be closing timbered in loose or sandy strata and below the surface of the sub-soil table. All timbering, sheeting and piling with their walls and supports shall be of adequate dimensions and strength and fully braced and strutted so that there is no risk of collapse or subsidence of the walls of the trench. The Contractor shall be held accountable and responsible for the adequacy of all timbering, bracing, sheeting and piling used and for all damages to persons and property resulting from the improper quality, strength, placing, maintenance, or removing of the same.

7.0.24 Removal of water.

The Contractor shall at all times during the progress of work keep the trenches and excavations free from water at his own expense which shall be disposed off by him in a manner as will neither cause injury to public health nor to public or private property, to the work completed or in progress, to the surface of any roads or streets and cause any interference with the use of the same.

7.0.25 Trench width.

The width of excavated trenches shall be as per the table given below:

Excavation upto:	Width at bottom		
	Upto 100 mm dia pipe	Upto 150 mm dia pipe	Upto 300 mm dia pipe
900 mm depth	330 mm	330 mm	600 mm
900 to 1500 mm depth	600 mm	600 mm	900 mm
1500 to 3000 mm depth	750 mm	750 mm	1100 mm
3000 to 5000 mm depth	900 mm	1000 mm	1300 mm

7.0.26 Protection of existing services.

All pipes, water mains, cables, etc. met with during the course of excavation shall be carefully protected and supported.

7.0.27 Road crossings

All pipelines laid below roads shall be taken through suitable underground trenches. The size of trenches shall be as per drawings.

7.0.28 Construction across roads.

All works across roads shall be carried out as per the directions of the Construction Managers / Professional Team.

8.0 EXTERNAL DOMESTIC SEWERAGE.

8.0.1 Stone Ware Pipes.

The SW pipes will be as per IS: 651 and will be of 600/750 mm pieces with socket and spigot ends.

The pipes required for this project will be procured and supplied by the contractor to project site.

Jointing of the pipes including supply of cement mortar and other material as required is to be considered by the tenderer.

8.0.2 Laying of Pipe Lines.

i. General.

The trench shall be so dug that the pipe can be laid to the required alignment and at the required depth. When the pipeline is under a roadway, a minimum cover of 90 cm is recommended for adoption, but it may be modified to suit local conditions. The trench shall be excavated only so far in advance of pipe laying as specified by the authority. The trench shall be so shored and drained that the workmen may work therein safely and efficiently. The discharge of the trench de-watering pumps shall be conveyed either to drainage channels or to natural drains.

ii. Trenching.

The excavation should be carried out with manual labour or with mechanical equipment as approved by the authority.

iii. Width of Trenches.

Unless otherwise specified by the Authority, the width at bottom of trenches for different diameters of pipes laid at different depths shall be as given below.

- a) For all diameters, up to an average depth of 1.2 m, width of trench in mm = diameter of pipe + 300mm.
- b) For all diameters for depths above 1.20 m, width of trench in mm = diameter of pipe + 400 mm.
- c) Notwithstanding (a) and (b) the total width of trench should not be less than 0.75 m for depths exceeding 0.9 m.

iv. Limits of Excavation Relative to Gradients.

Except where special foundations are to be provided, the trench shall be excavated in accordance with the following as may be considered appropriate by the Authority.

- a) The trench shall be excavated to the exact gradient specified so that no making of the subgrade by backfilling is required and the concrete bed, where required, may be prepared with greatest ease giving a uniform and continuous bearing and support for the pipe.

v. Trimming of Trench Bottoms.

The bottom of the trench shall be properly trimmed off to present a plain surface and all irregularities shall be leveled. Excavation shall be at joints to such dimension as will allow the joints to be conveniently and thoroughly filled.

vi. Laying of Stoneware Pipes.

The stoneware pipes shall be laid with sockets facing up the gradient on desired bedding. Special bedding concrete shall be provided below the pipes (Ref. IS: 4127). All the pipelines shall be laid perfectly true to the line and gradient. At the close of each day's work or at such other times when pipe is not being laid, the end of the pipe shall be protected by a close fitting stopper.

8.0.3 Jointing.

Joints of stoneware may generally be spigot and socket joint (rigid type).

i. Caulking of yarn.

In each joint, spun yarn soaked in neat cement slurry shall be passed round the joint and inserted in it by means of a caulking tool. More skeins of yarn shall be added if necessary and shall be well caulked. Yarn or gasket so rammed shall not occupy more than one-fourth of depth of socket.

ii. Caulking of cement mortar.

Cement mortar (1:1) (one part of cement to one part of sand) shall be slightly moistened and carefully inserted by hand into the remaining space of the joint after caulking of yarn. The mortar shall then be caulked into the joint with a caulking tool. More cement mortar shall be added until the space of joint has been completely filled with tightly caulked mortar. The joint shall then be finished off neatly outside the socket at an angle of 45 degrees.

8.0.4 Curing.

The cement mortar joints shall be cured at least for seven days before testing.

8.0.5 Hydraulic Testing of Pipe Sewers.

i. Water Test.

Each section of sewer shall be tested for water tightness preferably between manholes. To prevent change in alignment and disturbance after the pipes have been laid, it is desirable to backfill the pipes upto the top keeping at least 90 cm length of the pipe open at the joints. However, this may not be feasible in the case of pipes of shorter length. With concrete encasement or concrete cradle, partial covering of the pipe is not necessary.

In case of concrete and stoneware pipes with cement mortar joints, pipes shall be tested three days after the cement mortar joints have been made. It is necessary that the pipelines are filled with water for about a week before commencing the application of pressure to allow for the absorption by pipe wall.

The sewers are tested by plugging the upper end with a provision for an air outlet pipe with stop cock. The water is filled through a funnel connected at the lower end provided with a plug. After the air has been expelled through the air

outlet the stop cock and water level in the funnel is raised to 2.5 m above the invert at the upper end. Water level in the funnel is noted after 30 minutes and the quantity of water required to restore the original water level in the funnel is determined. The pipe line under pressure is then inspected while the funnel is still in position. There shall not be any leaks in the pipe or the joints (small sweating on the pipe surface is permitted). Any sewer or part there of that does not meet the test shall be emptied and repaired or relayed as required and tested again.

The leakage or quantity of water to be supplied to maintain the test pressure during the period of 10 minutes shall not exceed 0.2 liter/mm dia. of pipes per kilometer length per day.

For non-pressure pipes it is better to observe the leakage for a period of 24 hours if feasible.

8.0.6 Backfilling of the Trenches.

Backfilling of the sewer trench is a very important consideration in sewer construction. The method of backfilling to be used varies with the width of the trench, the character of the material excavated, the method of excavation and the degree of compaction required. In developed streets, a high degree of compaction is required to minimize the load while in less important streets, a more moderate specification for back fill may be justified. In open country it may be sufficient to mound the trench and after natural settlement return to regrade the areas.

No trench shall be filled in unless the sewer stretches have been tested and approved for water tightness of joints. However, partial filling may be done keeping the joints open to avoid disturbance. The refilling shall proceed around the above the pipes. Soft material screened free from stones or hard substances shall first be used and hand pressed under and around the pipes to half their height. Similar soft material shall then be put upto a height of 30 cm above the top of the pipe and this will be moistened with water and well rammed. The remainder of the trench can be filled with soft and hard material, in stages, each not exceeding 60 cm. At each stage, the filling shall be well rammed, consolidated and completely saturated with water and then only further filling shall be continued. Before and during the backfilling of a trench, precautions shall be taken against the floatation of the pipe line due to the entry of large quantities of water into the trench causing an uplift of the empty or the partly filled pipe line. Upon completion of the backfill, the surface shall be restored fully to the level that existed prior to the construction of the sewer.

8.0.7 Construction of Manholes.

i. General.

The manholes shall be constructed simultaneously with the sewers. The manhole shall normally be of brick-work in cement mortar and generally be plastered inside. The foundation of manholes shall be cement concrete of appropriate grade. The floor of the manhole shall be in cement concrete with

formation of half channel of the required size and curve to the same line and fall as the sewer. Both sides of the channel pipes shall be benched up in concrete and formed to a slope to the channel. All round the pipe there shall be a joint of cement mortar between the pipe and the bricks. The ends of the pipes shall be built in and neatly finished off with cement mortar. The masonry shaft or the manhole shall be provided on the top with a heavy air tight R.C cover slab. Where the depth of the manhole exceeds 90 mm below the surface of the ground, steps of cast iron of any other approved material shall be built into the brick work.

The entire height of the manhole shall be tested for water-tightness by closing both the incoming and outgoing ends of the sewer and filling the manhole with water. A drop in water level not more than 50 mm per 24 hours shall be permitted. In case of high subsoil water, it should be ensured that there is no leakage of ground water into the manhole by observing the manhole for 24 hours after emptying it.

ii. Sewer Connections.

The sewer, after insertion into the manhole, shall be aligned to grade and supported. The gap on the outer face of pipe shall be filled with cement mortar.

8.0.8 Mode of measurement.

Stoneware pipes shall be measured along the centerline of the pipeline including the specials in running meter (Rm.) between:

- a) Chambers/Manholes: Shall be recorded from the inside of one manhole to inside of another manhole.
- b) Gully trap and manhole: shall be recorded between socket pipe near gully trap and inside of manhole.

The quoted rate shall include the following:

- i) The cost of pipes, specials and other jointing materials.
- ii) Laying, jointing and curing.
- iii) Testing and making good the defects if any.

8.0.9 EXTERNAL WATER SUPPLY.

8.0.9.1 General.

Drinking water is supplied from Water Treatment Plant to OHT-1 & OHT-2 at the terrace floor of the Hospital building through drinking water pumping/ delivery line.

8.0.9.2 Scope of Work.

The Delivery lines and Overflow lines between WTP and OHT-1 & OHT-2 at the terrace floor of the Hospital building for drinking water supply are in the scope of tenderer.

8.0.9.3 GI Pipes and fittings for external water distribution.

GI pipes and fittings shall be used for cold and hot water services above and below ground applications. All exposed piping in terrace, shafts and buried shall be of medium quality (Class B) and all concealed pipes including above false ceiling shall be heavy quality (Class C) galvanised iron, screwed socketed and shall conform to IS 1239 (Part-I). All fittings shall be malleable iron galvanized fittings of approved best Indian make. The details of pipes and sockets regarding nominal bore, thickness and weight in kg/m are as per IS-1239 (Part-I).

The following manufacturing tolerances shall be permitted on tubes and sockets.

8.0.9.3.1 Thickness.

- | | |
|----------------------------|--|
| i) Light tubes butt welded | : + Not limited - 8 percent |
| ii) Medium and Heavy tube | : + Not limited - 10 percent butt welded |
| iii) Medium tubes seamless | : + Not limited - 12.5 percent |

8.0.9.3.2 Weight.

- | | |
|--|----------------------------|
| i) Single tube (light series) | : + 10 percent - 8 percent |
| ii) Single tube (medium and heavy series) | : + /- 10 percent |
| iii) For quantities per load of 10 tonnes,
Min(light series) | : + /- 5 percent |
| iv) For quantities per load of 10 tonnes,
Min (medium and heavy series) | : + /- 7.5 percent |

8.0.9.3.3 Laying and fixing.

Where pipes have to be cut or re-threaded, ends shall be carefully filed so that no obstruction to the bore is offered. For internal work all pipes and fittings shall be fixed truly vertical and horizontal, either by means of standard pattern holder bat clamps keeping the pipes 1/2" (12mm) clear of the wall everywhere or concealed as directed. For external work, G.I. pipes and fittings shall be laid in trenches. The width of the trench shall be the minimum width required for working. The pipes laid underground shall be not less than 60cm. from the finished ground level and a minimum horizontal distance of 60CM shall be maintained between other services lines.

8.0.9.3.4 Wrapping of concealed GI pipes.

i Cleaning.

Pipe surfaces shall be thoroughly cleaned and dried before tape is applied and shall be free of dirt, grease and rust scale or other foreign matter. The pipe shall be cleaned mechanically.

Oil and grease, if present on the pipe surface should be removed by using a suitable solvent and clean rags. The use of dirty, oily rags should not be permitted.

ii Field Application of tape.

The tape shall be wrapped in accordance with the manufacturers recommendations in a manner that shall meet the adhesion requirement. During application, care shall be taken to ensure that there are no air pockets or bubbles beneath the tape.

The tape should be wrapped with an overlap of 50% for TEES. The first wrapping shall be done individually. The tape may be cut if required to suit the profile. There shall be two layers of tape wrappings. The first layer is to be wrapped on the pipe directly after cleaning the pipe surface. The second layer is to be applied over the first layer. The second layer should also be wrapped with 50% overlap.

8.0.9.3.5 Testing.

Before any pipes are painted or covered, they shall be tested to a hydrostatic pressure of 7kg/sqcm. Or twice the working pressure of the pumping main whichever is lighter. Pressure shall be maintained for atleast eight hours without an appreciable drop in pressure. In addition to the sectional testing of water supply pipes, the contractor shall test the whole installation to the entire satisfaction of the Engineer in charge. He shall rectify any leakages, failure of fittings or valves.

8.0.9.3.6 Disinfection of the pipe network.

The entire water distribution network is to be disinfected by using residual chlorine of 0.2 ppm for a period of 2 (two) hours. The entire chlorinated pipe network is to be flushed out with fresh water before the water supply system is put into operation for domestic usage.

8.0.9.3.7 Mode of measurement.

G.I. pipes above ground shall be measured along the centre line of the pipes and fittings. The quoted rate for respective item shall be per Rmt and shall include the following:

- a) Cost of respective pipes and specials.
- b) Laying, fixing and jointing with standard pipe clamps available for different sizes inside the wall chase and fixed on MS angle iron brackets and GI U clamps for pipes in ducts as shown on the drawing.
- c) Cutting holes and chases in walls, floors, etc. And making good the same.
- d) All supporting arrangements, brackets, etc.

Testing and making good the defects, if any. G.I. pipes below ground shall be measured as stated elsewhere in the specifications.

9.0 Valves, strainers and pressure gauges.

9.0.1 General.

This section deals with different type of valves like butterfly valves, gate valves, ball valves, check valves, and pressure gauges. The contractor shall refer to the approved make of materials specified herein and the drawings.

Valves shall be provided on branch pipe connections to mains and at connection to equipment where indicated. All valves are to be located for easy access. All valves shall be supported wherever necessary with MS brackets. Valves shall comply with IS 780 (Class I) for C.I sluice valves and IS 778 for G.M valves.

Pressure gauges shall have outer diameter not less than 115mm with 10mm BSP full thread, brass body syphon and gauge cock of size 10mm. Dial gauges

shall have adequate response for the pressures encountered within the specified (Range 0-15Kg/sq.cm).

9.0.2 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.

9.0.3 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 off 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.

9.0.4 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.

9.0.5 Butterfly valves.

Butterfly valves shall be slim seal, short wafer type with standard finish. The valves shall be suitable for mounting between flanges drilled to ANSI 125. The valve body shall be cast iron. The disc shall consist of disc pivot and driving stem shall be in one piece centrally located. The disc shall move in bearings on both ends with 'O' ring to prevent leakage. The seat shall be moulded with black nitrile rubber or nylon and shall line the whole body. The spindle shall be AISI 41 steel. The valve shall be suitable for a working pressure of 16.5 kg/sq.cm and shall be complete with flow control lever and notches, factory machined companion flanges and bolts and nuts. These valves conform to BS 5155 with electro steel nickel coated SG Iron (N) and seat material EPDM3.

9.0.6 Check valves.

Check valves are designed to prevent reversal of flow. These are also called Non-return valves or reflux valves to avoid reversal of flow. Check valves shall be Dual Plate check valves with CI body, aluminum bronze plate SS 316 hinge pins and springs and Buna-N seals to ANSI series 125. They can also conform to IS 778-1984, Specifications for Copper Alloy Gate, Globe and Check Valves for Water Works.

9.0.7 Flanges and unions.

Sufficient number of flanges and unions shall be provided as required to facilitate maintenance work after the piping is installed. Mild steel flanges shall be used for pipes. The flanges shall be connected to the pipeline by screwing or welding depending on the requirement. The flanges shall conform to the relevant ASTM standard for the particular material used for its manufacture. The flanges shall also conform to IS 5211.

9.0.8 Level sensors.

Level sensor shall consist of control unit, preamplifier and one full insulated probe-mounted vertically or two part insulated probe mounted from tanks side wall adjustable switching system for pump control application, the same to be housed in stove enamel painted cast aluminum weather proof suitable for black panel / wall mounting etc.,

The enclosure of probes shall be manufactured with SS316 material. The least count of the central unit with amplifier should be $\pm 0.10\text{mm}$ for response value of 30 seconds. Level sensors shall be provided with controls housed in control panel of the pumps.

9.0.9 Installation of valves.

Valves should be installed in true tolerance of $\pm 5\text{mm}$ with respect to the centerline of the pipe. Where threaded joints are encountered the threads should be initially sealed with PVC tape to avoid leakage due to improper tightening and leakage from threading.

Proper care has to be taken in welded installation so that the centerline of valve should not deviate from the pipe causing uneven load on the pipe and further stress during its operation. The welding should be done only after proper

inspection of the joint by the Construction Managers / Professional Team in the tacked position of the joint.

Before putting the line in operative mode the valves should be checked for free and easy operation of the hand wheel. Any burrs or foreign materials should be removed by flushing before final operation so that no choking in the valves should occur which might damage the valve seating.

9.0.10 LIST OF APPROVED MAKES.

SUBJECT: APPROVED MAKE OF MATERIALS FOR PHE WORKS

NOTE : The Contractor / Vendor has to base his pricing ONLY on the First preference of approved makes indicated below. The Contractor shall indicate the choice in the column titled "Contractor Selection" and the same will be approved by the Architect / Owner. In case of any substitution during the course of the project the same needs to be submitted to the Architect for approval and the cost reduction to be indicated clearly along with the approval.

SL NO	DESCRIPTION OF ITEMS	ALTERNATIVE S	Approved makes 1st Preference	Approved makes 2nd Preference	Approved makes 3rd Preference	Contractor Selection	REMARKS
1	CPVC Pipes	/	Astral Polytechnik				
		/	Ashirvad pipes				
		/	Ajay industrial corp				
2	GI Pipes	/	Tata	GST			
		/	Jindal	Surya Prakash			
		/	Zenith	Kalinga			
3	GI Fittings	/	R Brand	HB			
		/	Unik	AMCO			
		/	New				
4	PVC Pipes /HDPE pipes	/	Kisan	Sudhakar			
		/	Supreme	Finolex			
		/	Prince				
5	CI Frame & Cover	/	Neco				
		/	BIC				
		/	RIF				

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6	SFRC (Precast) Frame & Cover	/	Southern Industries	Concrete				
		/	Rajvaibhav Enterprises					
7	Plastic Rungs PVC Encapulated	/	Omp Plast					
		/	Rajvaibhav Enterprises					
8	Gate Valves	/	Leader	Sant				
		/	Zoloto	GG				
		/	Neta					
9	Ball Valves	/	Leader	GS				
		/	Zoloto	RB				
		/	Audco					
10	Butterfly Valves	/	Audco	BDK				
		/	Intervall	Keystone				
		/	Advance					
11	Non - return valves	/	Zoloto					
12	Puddle Flanges	/	Tata / Jindal make pipes with hot dip bath galvanization					
13	Air Release Valves	/	Leader					
		/	Zoloto					
		/	Hawa					
14	Water Meters	/	Dashmesh	Kent				
		/	Capstan					
15	Stone Ware pipes	/	ISI Brand					
		/	Approved Equivalent					
16	RC Hume Pipes	/	Southern Industries	Concrete				
		/	Indian Hume pipes					

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17	Pumps	/	Grundfos	Kirloskar			
		/	DP	Beacon			
		/	Lowara ITT Industries	KSB			
18	Auto level controller &	/	Alfa Laval				
	water level indicators	/	Approved Equivalent				
19	Electrical Switchguges &	/	Siemens				
	amplifier equipment	/	L &T				
20	Magnetic flow meter	/	Yokogawa/Blue star/Krohne Marshall/Fisher Rosemount or Equivalent.				
21	Cables	/	Universal/Omega/Torrent/Asian				
22	Chain Pulley Block	/	Indef/Ardee/J.K. Morris				

TECHNICAL SPECIFICATION FOR MEP & UTILITY SERVICES

SECTION I

CIVIL, PLUMBING AND SANITARY

SPECIFICATIONS AND CONDITIONS

1.0 GENERAL:

The work shall in general conform to the CPWD specifications for works 2009 Vol. I and Vol. II with correction slips issued up to the date of receipt of tender. Wherever some aspects of design / construction / material standards are not covered under the above mentioned specification, relevant international standards shall be referred to:-

In case of discrepancy among these standards, the order of precedence shall be as follows

- a) Provision in the schedule of Quantities.
- b) The Specification given in this section.
- c) CPWD specifications.
- d) BIS, IRC, BS, ASTM, DIN (in that order)

2.0 STRUCTURAL GLAZING

The structural glazing shall be carried out as per the description of item provided in the Bill of quantities and as directed by the Engineer-in-charge. The Structural glazing is to be Semi Unitized Structural Glazing system.

2.1 SCHEDULE OF TESTS

2.1.1 Site Tests for Water Penetration:

Site test shall be performed as follows.

2.1.2 STATIC PRESSURE

This test shall be performed by attaching the test specimen on one side of the pressure chamber and sealing it with same type of sealant as would be used on site. Uniform pressure difference of 60 kg/m² shall be introduced into chamber in one step for ten minutes. The test shall then be repeated with a pressure difference of 120 kg/m² (60% of positive wind pressure) for 5 minutes.

Water jet spray shall be introduced onto the specimen at a rate of 3.40 liter per square meter per minute.

2.2 GLASS

2.2.1 Tests in Approved independent laboratory:

3 samples of each type of vision and spandrel panels (except for glass with ceramic frit) shall be tested for:

- (a) American summer U- Value in W1m (ASHRAE standard)
- (b) Shading coefficient (ASHRAE standard)

2.2.2 Certification by Manufacturer:

For each lot of glass supplied, the Manufacturer shall certify. The following:

2.2.2.1 Characteristics

- Light transmittance (380 to 780 nm.) %
- Light reflectance (external): %
- Light reflectance (internal): %
- UV transmittance (280 TO 380NM): %
- Direct energy transmittance (300 to 2150 nm) %
- Energy reflectance: %
- Energy absorption: %
- Shading coefficient %

$$= \frac{\text{Total solar energy flux entering thru glass}}{0.87 \times \text{incident solar energy}}$$

- U - value (American summer): $\text{W/m}^2.\text{K}$

ASHIRAE conditions

2.2.2.2 Compliance with Codes:

- ASTM C 1036-9 1 for vision glass
- ASTM C 1048-92 for spandrel glass
- CBA rating with IGCC in accordance with ASTM E 773 and E 774 for insulating glass
- ASTM C 1048—92 for heat-processing
- ANSI Z 97.1 and CPSC 16 CFR 1201 for safety glazing.

2.2.2.3 Sealant — Substrate test report

2.2.2.4 Surface compression in heat strengthened glass

2.2.2.5 Manufacture's certification of cyclic thermal stress test as per ASTM C 1048-92 on heat processed glass.

2.2.2.6 Manufacturer's report on heat- soaking program for each lot of glass supplied.

2.2.2.7 Visual Inspection Reports.

- ❖ Thickness and dimension tolerances
- ❖ Pinholes
- ❖ Uniformity of colour and opacity
- ❖ Distortion
- ❖ Scratches

2.3 STRUCTURAL SEALANT:

2.3.1 Tests on 1 — component sealants:

2.3.1.1 Skin —over Time /Elastomeric Test:

Perform test in fabrication shop on each new lot and once a week to check on shelf life of one-part sealant as recommended by the manufacturer.

2.3.1.2 Standard field adhesion Test:

Perform 10 tests for the first 300 sq. m. of sealant application and 1 test for every 300sq.m. Thereafter in fabrication shop as recommended by sealant manufacturer.

2.3.2 Tests on 2-component sealants:

2.3.2.1 Perform test every time mixing pump is started up to check on adequate mix of base and curing agent components.

2.3.2.2 Snap — Time Test

Perform test daily to relate the mix proportion to the curing rate of sealant as recommended by the manufacturer.

2.3.3 Deglazing

Deglaze complete panels from frame to confirm proper adhesion and joint fill.

Inspection of at least 3% of first 100 glazed panels and at least 1% of panels thereafter shall be carried out after deglazing in presence of the sealant manufacturer.

The following documentation shall be certified jointly by the sealant manufacturer and the contractor:

- (a) Size of structural joint - design and actual.
- (b) Size of structural glue-line.
- (c) Adhesion of sealant with panel and frame
- (d) Joint type /condition penetration of sealant applied.

2.3.4 Laboratory Tests by Manufacturer:

- (a) Peel adhesion test as per ASTM C 794-93.

- (b) Compatibility test for sub-strates as per ASTM C 1248-93.
 - (c) Indentation Hardness durometer test as per ASTM C 66 1-93.
 - (d) Adhesion &. Cohesion test under cyclic movement as per ASTM C 7 19-93.
 - (e) Tensile adhesion test as per ASTM C 1135-90
 - (f) Ultimate elongation & tensile strength as per AS1'M D 412.
- 1 set of Test certificates shall be submitted for each lot supplied.

2.3.5 The sealant Manufacturer shall submit laboratory test results for adhesion and compatibility for each lot of aluminium extrusions and glass.

2.4. Aluminium Extrusions:

2.4.1 Each lot and type of aluminium extrusions shall be accompanied with:

- (a) Certificate of mechanical properties and chemical composition.
- (b) Certificate of dimensional tolerances to DIN standard.
- (c) Certificate of temper.

2.4.2 The contractor shall certify minimum anodizing thickness for each lot and type of aluminium extrusions.

2.4.3 Anodising thickness shall be checked on site on 10% of extrusions.

2.4.4 PVDF coating thickness shall be checked on site on 10% of extrusions.

2.5. Composite Aluminium Panels:

2.5.1 The manufacturer shall submit one test certificate for each lot and type of composite aluminium panels for:

- (a) Tensile strength and yield strength of composite panels as per ASTM E-8
- (b) Tensile and yield strength of aluminium skin.
- (c) Elongation as per ASTM E 8
- (d) Punching shear resistance as per ASTM D 732
- (e) Impact test for denting (DUPONT) (0.5 kg and 1 kg steel balls at 500 mm height)

2.5.2 The following test result from approved fire test laboratory shall be Submitted:

- (a) Flame spread and smoke developed indices as per ASTM E 84.
- (b) UBC 26-9 & NFPA for 30 Minute Intermediate scale multi storey apparatus test to prove no flame spread beyond area exposed directly to fire source.

2.5.3 The following test certificates shall be submitted for PVDF/ fluoropolymer coating satisfying AA 2605 —98

- (a) Corrosion resistance
- (b) Salt spray resistance
- (c) Weathering
- (d) Colour retention
- (e) Chalking resistance
- (f) Glass retention
- (g) Resistance to erosion

2.5.4 The coating agency shall certify performance requirements of all tests as per AAMA 2605-98 — voluntary specification, Performance Requirements and Test procedures for superior performing organic coating on Aluminium Extensions & Panels.

2.5.5 The coating agency shall certify the minimum thickness of PVDF / fluoropolymer coating.

The Manufacturer shall certify conformance with BS 476, Part 6, and Class 0 and Part 7, Class 1 6.5. The manufacturer shall certify the percentage of resin in PVDF / fluoropolymer coating.

2.6. E.P.D.M.

4 each lot of EPDM, test certificates shall be submitted for

- (a) Shore hardness.
- (b) Tensile strength.
- (c) Elongation
- (d) Ozone resistance.

2.7 GLASS:

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

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

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

- 2.7.4 Heat strengthened glass shall not deviate in surface flatness by more than 0.23 mm within 260mm of leading or trailing edge, or 0.076mm in centre. Direction of ripple shall be consistent and is acceptable to Architect. Distortion of glass shall be controlled as much as possible during heat strengthening. Sag distortion shall be uni-directional 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.
- 2.7.5 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.
- 2.7.6 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 be consistent in colour.
- 2.7.7 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.
- 2.7.8 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.

3.0 ALUMINIUM COMPOSITE PANELS

The Aluminium Composite panel using 4mm thick composite panels(Eurobond, Durabuild or equivalent) consisting of 3.0mm thick polythelene resin core sandwiched between 2 skins of 0.50mm thick aluminium sheet (alloy designation 310S) tensile strength 16.67 kg/cm³ making a total panel thickness of 4mm. The top surface is coated with Kynar 500 / Hylar 5000 PVDF based fluoro carbon coating as per ASTM standards, the bottom surface is to be coated with anticorrosion primer paint. The core material is to be a mixture of high quality grade LDPE AND HDPE. Adhesive film from DUPONT, USA or equivalent Protective film of good quality is to be used to avoid leaching effect. The supporting framework shall be made to suit the grid requirement at site out of extruded section of 38x38x3mm aluminium angle or 50x25x2mm tube section running vertically or horizontally fixed to building structure through M.S/ aluminium clamps prefixed to masonry with suitable anchor fasteners. After aligning the framework for level and line the ACP panel cut to size and bent at

edges to form a tray to be fixed to aluminium grid with metal screws. All hardware will be corrosion resistant. The gaps sealed with weather sealant like Dow corning 789 or equivalent with necessary hardware etc all complete.

4.0 LOUVERED PANELS

- 4.1 Louvered panels shall be provided at positions as shown in the drawings.
- 4.2 Louvers shall be of approved anodized aluminium with an assumed efficiency of 50% unless otherwise specified and shall be complete with stainless steel bird-proof wire fixed internally.
- 4.3 All hardware and accessories shall be, when exposed, of non- magnetic stainless steel and/ or coloured aluminium to match that of structural glazing / cladding wherever possible.

5.0 FABRICATION

- 5.1 **General:** All assemblies shall be fabricated and assembled in accordance with the drawings and the requirements of these specifications. Deviations of any nature, without approval of HLL shall not be permitted.
- 5.2 **Tolerances:** Furnish a schedule of fabrication tolerances for all major wall cladding components. In addition to the fabrication tolerances, provide for and schedule thermal movement including assembly and installation tolerances for all major and/or applicable wall cladding components and/or assemblies.

5.3 Workmanship

- a. All work shall be performed by skilled workmen, specially trained and experienced in the applicable trades and in full conformity with the applicable provisions of the listed References and Standards and / or otherwise noted in the drawings or as specified herein.
- b. All work shall be carefully fabricated and assembled with proper and approved provisions for thermal expansion and contraction, fabrication and installation tolerances and design criteria.
- c. All forming and welding operations shall be done prior to finishing, unless otherwise noted.
- d. All work shall be true to detail with sharp, clean profiles, straight and free from defects, dents, marks, waves or flaws of any nature impairing strength or appearance; fitted with proper joints and intersections and with specified finishes.
- e. All work shall be erected true to plumb, level, square to line, securely anchored, in proper alignment and relationship to work of other trades and free from waves, sags or other defects.

6.0 Shop Drawing, Inspection and Testing.

6.1 Working and construction drawings.

The contractor shall prepare shop drawings and all work shall be according to approved working drawings. Shop drawings shall give all dimensions and shall incorporate the requirements of the clients / Engineer – In-Charge. Approval of drawings does not relieve the contractor of his responsibility to meet the intents of the specifications. All such drawings for approval shall be submitted in 6 copies to the Engineer – In-Charge.. In addition, the contractor shall submit manufacturer's details and get them approved before ordering. This has to be done whether the materials / equipment are one of the approved makes or not.

6.2 Testing and Inspection

The contractor shall carry out tests on different equipment and system in total as specified in various sections of the tender in the presence of the Engineer – In-Charge. in order to enable them to determine whether the plant, equipment and installation in general comply with the specifications. All equipment shall be tested after carrying out the necessary adjustments and balancing to establish equipment ratings and all other design conditions. The test data shall be submitted in Acceptance Test Form.

6.3 Calibration of instruments and meters.

Instruments required for testing shall be furnished by the contractor for testing with initial requirements of all consumables. All the instruments, meters etc to be used at site and on the system shall have a valid calibration certificate issued by the competent authority. The contractor shall maintain and make available all such calibration certificates.

7.0 Handing over requirements.

The work shall be handed over after satisfactory testing along with 6 sets of the following documents along with CDs (Soft copy).

1. Detailed equipment data in the approved Performa
2. Manufacture's maintenance and operating instructions manuals
3. Set of as built drawings, layouts, piping, ducting, cable routing, cable schedules etc
4. Approved test readings of all equipment and installations
5. Inspection certificates
6. Warranty / guaranty certificate for all equipments
7. List of recommended spares together with list of suppliers and their contact details.

8. Certificate from the contractor that he has cleared the site of all debris and litter caused by him. However, contractor has also to periodically clear the site from all the debris, which is generated from his part of scope.
9. Undertaking that all the materials supplied by him at site are fully tax paid and shall produce all documentation for satisfaction of the Engineer- In-Charge.

Submission of the above documentation shall form a precondition for final acceptance of the plant and installation and final payments.

8.0 Statutory approvals inspection.

- 8.1** The contractor shall be fully responsible for meeting all the statutory obligations and local inspectorates wherever applicable to the works carried out by them. The contractor should prepare all working drawings and obtain approval of competent authorities and also have the equipment and installation inspected and got approved. All obtaining approval fee and deposit towards statutory approval and inspection paid against demand in writing from the appropriate authority will be reimbursed on submission of original receipts. All other expenses for submission and approval of the various and relevant statutory / bodies shall be embodied in the tender prices.

8.2 Licensed plumber.

All work performed by the contractor shall be through licensed plumbing supervisor possessing a valid plumbing contractors license employing Engineers, Technicians, Foremen, Plumbers, Masons, Helpers, etc., as required.

8.3 Fees, permits and notices.

Contractor shall comply with all bye-laws and regulations of local and other statutory authorities having jurisdiction over the works and shall be responsible for the payment of all fees and other charges and giving and receiving of all necessary notices. Contractor shall keep the Engineer-in-Charge timely informed about regulations and requirements of statutory Authorities and shall obtain the final certificates of inspection and approval from the authorities.

8.4 Specifications and drawings.

The specifications and drawings shall be considered as part of this contract and any work or materials shown on the drawings and not called for in the specifications or vice versa shall be executed as if specifically called for in both. The tender drawings indicate the extent and general arrangement of the fixtures, drainage system, etc. The drawings indicate the points of supply and

termination of work shall be installed as indicated in the drawings. However, any changes found essential to co-ordinate with this work and other trades shall be made without any additional cost. The drawings and specifications are meant for the assistance and guidance of the contractor, and exact location, distance and levels will be governed by the individual building and site conditions. Therefore, approval of the Engineer-in-Charge shall be obtained before commencement of work.

Exact routing and sizes of all piping on all the floors and the vertical stacks, Ground and invert levels of all drainage pipes together with location of all manholes and connections up to outfall shall also be got approved along with Run of all water supply lines with diameters, location of control valves, access panels, Location of all the mechanical equipments with layout and piping connections etc.

Contractor shall provide six sets of catalogues, 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.

All "Warranty Cards" given by the manufacturers shall be handed over to the Engineer-in-Charge.

8.5 Manufacturers instructions.

Where manufacturers have furnished specific instructions relating to the materials used in this job and methods of construction that are not specifically mentioned in these documents, such instructions shall be followed in all cases. The contractor shall also furnish six sets of the detailed instruction, operating and maintenance manuals including detailed completion drawings and Fire Safety Plans on a bound copy to approved scale. Further it is the responsibility of the contractor to train the Employer's/ Employer's Authorized representatives' personnel in the operation and maintenance of the system.

SECTION II

WATER TREATMENT PLANT

1.0 SPECIAL CONDITIONS

1.1. EXECUTION OF WORK

The whole of the work as described in the contract (including bills of materials, specification and all drawings pertaining thereto) and as advised by the Employers from time to time is to be carried out and completed in full to the entire satisfaction of the Employers. Any minor details of construction which are obviously and fairly intended, or which may not have been definitely referred to in this contract, but which are usual construction practice and essential to the work, shall be included in this contract.

1.2. MAINTENANCE & TRAINING FOR PERSONNEL

1.2.1 The contractor shall without any extra cost carry out for a period of 12 months after the installation is taken over by the owners, all routine and special maintenance and attend to any difficulties and defects that may arise in the operation of Water Treatment Plant.

1.2.2 The contractor shall associate with the Employers' staff during erection and the maintenance period, in the maintenance/operation of the Water Treatment Plant.

1.2.3 If required, by the Employers, the contractor shall also train members of the Employers' staff at their works/service station without any extra charge.

1.3. CERTIFICATE OF COMPLETION

1.3.1 The contractor shall intimate to HLL in writing as and when the works are completed and put into beneficial uses in order to enable HLL to check certify to take over the plants.

1.3.2 The work shall not be considered as completed and put into beneficial use until HLL have certified in writing that the same has been completed and put into beneficial use.

1.3.3 The defects liability period shall commence from date of such completion or any specific date mentioned therein.

1.4. OPERATIONAL AND MAINTENANCE MANUALS

- 1.4.1 The contractor shall also furnish the prints of all up-dated handing over along with required set of operating/maintenance manuals / instructions.
- 1.4.2 The Agency/contractor shall ensure adequate and prompt after sales service in the form of maintenance personnel and spares as and when required ensuring that all spares are easily available during the normal life of the installation. Every effort shall be made to provide zero defect performance during the guarantee period of 12 months (DLP) by undertaking preventive maintenance.

2.0 TECHNICAL SPECIFICATION

2.1. TECHNICAL INSTRUCTION TO TENDERER

2.1.1 SCOPE OF WORK

The Tenderer's scope of work shall cover the following:
Design and engineering of the following:

- a) WTP for treating the raw water consisting of pressure sand filters, disinfection system using sodium hypochlorite dosing systems, raw water pump sets, drinking water pump sets including all piping, fittings and valves etc. complete.

Flow meters are to be provided in WTP pump house for flow measurement on the delivery line of drinking water pumps, and also on raw water supply lines from tube wells and / Municipal supply line to fire water sumps.

- b) Necessary instrumentation required for smooth running of WTP. Tenderer shall note that all illumination of WTP and outside area is covered in this scope of tender.
- c) Necessary material handling facilities for WTP shall be provided.

2.1.02 Manufacture, procurement, assembly, shop testing, surface preparation, shop painting, packing, supply at site, storing at site for all equipment / items.

2.1.03 Erection of equipment at site.

2.1.04 Finish paint of equipment at site after erection.

2.1.05 Testing and commissioning of the equipment and whole treatment plant.

2.1.06 Demonstration of performance guarantee.

Construction of Super Speciality Hospital for Govt. Rajaji Hospital at Madurai, Tamil Nadu

2.1.07 Furnish all drawings, documents, load data and other information / data like fault diagnosis, operation and maintenance manual, etc., general arrangement and layout drawings, design calculations and equipment specifications, together with as built drawings for all mechanical and electrical installations.

2.1.08 All technological structures, support for equipment, etc. complete. Minor civil works for erection of equipment are also included in the scope of Tenderer.

2.1.09 Supply of spares for normal operation and maintenance of equipment for a period of 2 years to be reckoned from the date of taking over of the equipment by the client.

A list of spares shall be indicated in the offer and these spare parts shall be supplied to the client's store at site prior to commissioning of the equipment. No equipment shall be taken over by the client until these spares are supplied.

The Tenderer will be required to replenish at his own expense the stock of spares used up during the performance test and within guarantee period.

2.1.10 The Tenderer shall include in the scope the requirement of all lubricants, chemicals and other consumables for testing, commissioning and performance guarantee runs.

2.1.11 The Tenderer shall list out in offer and provide a complete new and unused set of all special tools and tackles required for operation and maintenance of equipment. Necessary material handling equipment shall also be part of these tools.

2.1.12 All necessary foundation bolts, puddle flanges, matching flanges and anchoring parts shall be in the scope of the Tenderer.

2.1.13 Any additional work / equipment and material which may not be specially mentioned in the specification but are required to make the equipment complete in every respect in accordance with technical specification and necessary for safe operation and guaranteed performance of the plant shall be covered and provided by the Tenderer.

2.1.14 The Tenderer shall consider in their scope for supply and laying of incoming supply lines for tube well water and municipal water and for which Design Limit (DL) scope is indicated in tender drawing. Drg No SAPL/CH/327/P/-/TN/0659.

2.1.15 The Tenderer shall consider in their scope for supply and laying of final treated drinking water line up to the design limit (DL) as indicated with tender drawing Drg No SAPL/CH/327/P/-/TN/0659.

2.1.17 WORKMANSHIP AND QUALITY CONTROL

- (i) The equipment supplied shall be new and best of their kind and of latest technology. All materials and equipment shall comply with the latest Indian standards and statutory requirements of the concerned State Governments. In absence of relevant Indian standards/ practices, any other internal standards acceptable to the Engineer-in-Charge may be followed, but the same shall be clearly brought out in the offer.
- (ii) The equipment shall be designed to have maximum reliability and ease of operation and maintenance.
- (iii) The Tenderer shall avoid offering sophisticated and complicated equipment where simple and proven equipment will achieve the specified requirements.
- (iv) Quality assurance plan shall be furnished after placement of order.

2.1.18 CODES AND STANDARDS

- (i) All equipment supplied shall be in conformity with applicable codes and standards. All codes and standards used / referred to shall be to their latest edition / version as on the date of the acceptance of the tender.
- (ii) All equipments shall conform to the provision of statutory and other regulations in force, such as Indian Explosive Act, Indian Factories Act, etc.
- (iii) All electrical equipment shall comply with the latest revision of Indian Electricity Rules and within the statutory requirement of the Government of India and State Government as regards safety, earthing and other provision specified therein for installation and operation of electrical equipment.

2.1.19 DEVIATION, ASSUMPTION AND ALTERNATIVE PROPOSALS

- (i) The deviations from specification in any respect shall be clearly defined and indicated by the Tenderer along with reasons in the offer. In case of no list of deviations submitted by the Tenderer, all requirement and provisions of the specification shall be automatically deemed to have been agreed and complied by the Tenderer.
- (ii) Any assumption made for calculations or working out details shall be indicated in the offer clearly by the Tenderer.

The Tenderer shall submit an offer which complies with the technical specification. However, the Tenderer, if desires, can submit in addition an alternative offer for a design which may differ from specification. Such alternative would be given careful consideration provided that adequate supplementary information drawings and data are submitted to permit a complete evaluation of the offer made.

2.1.20 PAINTING

- (i) All ferrous metal works shall be provided with corrosion resistant paint treatment applied in accordance with the best trade practice suitable for plant and equipment.
- (ii) The paints shall be obtained from reputed manufacturer. The formulation and application procedure shall be as per recommendation of the manufacturer for appropriate exposure conditions.
- (iii) All shop painting shall be applied after proper surface preparation and application of suitable primer.
- (iv) Final / touch –up painting shall be done at site after erection of equipment.
- (v) In case the equipment operating conditions require any other special painting, the Supplier shall indicate the same in the offer.

2.1.21 IDENTIFICATION MARKING

- (i) Flow direction shall be marked on the various fluid piping in contrast colour shade.
- (ii) Equipment part number / name shall be marked on all equipment parts and machinery. Match-marks, wherever necessary, shall be provided for facilitating erection.

2.1.22 INSPECTION AND WORKS TESTING

- (i) The plant and equipment will be subjected to inspection and witnessing of tests by the Engineer-in-Charge. The supplier shall inform the Purchaser / his Consultants at least fifteen days in advance of the date when the plant and equipment will be made available for shop inspection and testing.

- (ii) The Engineer-in-Charge shall be allowed to use free of cost all the testing facilities available with the Manufacturer for the purpose of testing.
- (iii) Necessary tests, for which adequate facilities are not available with the Supplier / sub – contractor, will be carried out at mutually agreed testing laboratories at the cost of contractor.
- (iv) Inspection and works testing shall be carried out based on approved drawings and specifications and as per relevant standards.
- (v) Copy of the order on the sub-suppliers, comprising all the detailed specification and bill of materials shall be provided to the Engineer-in-Charge along with or before inspection call.
- (vi) The Supplier shall inspect the equipment / part before offering to the Engineer-in-Charge for inspection and satisfy himself with regard to the quality and quantity and issue an internal inspection certificate along with manufacturer's test certificate to the Purchaser.
- (vii) The Supplier shall not dispatch the materials from his works unless it has been inspected, tested and accepted by the Engineer-in-Charge unless specific approval for the same is given by Engineer-in-Charge. In either case, the material shall be dispatched by supplier only after issue of dispatch clearance by Engineer-in-Charge.
- (viii) The Engineer-in-Charge shall have the full right to accept or reject the materials, if during inspection and testing, the materials are found not conforming to specification and / or standard.
- (ix) Inspection by the Engineer-in-Charge shall not relieve the Supplier of his liability for rectifying defects which may subsequently appear or be detected during or after erection. After rectification, the testing of the plant and equipment shall be repeated to the satisfaction of the Purchaser.

2.1.23 PACKING, DISPATCH, HANDLING & TRANSPORTATION

- (i) Packing and weather proofing shall be subject to approval of the Engineer-in-Charge. This approval will be general and may not be required every time for an article or group of articles to be dispatched. However, the Engineer-in-Charge reserves the right to examine the

packing for any particular consignment at Supplier's/Manufacturer's works before dispatch.

- (ii) The Supplier shall be entirely responsible for the insurance, shipment, handling and transportation of all equipment, construction tools, labourers and materials including unloading at destination, transporting to site, off-loading, storing and protection at site till erection.

2.1.24 ERECTION, TESTING & COMMISSIONING

- (i) The equipment supplied shall be erected, tested and commissioned individually as well as for integrated operation.
- (ii) All site tests on plants shall also subject to prior approval by Engineer-in-Charge. The Supplier/contractor shall submit to Engineer-in-Charge or his representative the list of pre-commissioning tests intended to be carried out. This list will be reviewed and finalized before commencement of tests.
- (iii) The tests shall be carried out as per mutually agreed schedule so that they may be witnessed by Engineer-in-Charge.
- (iv) The execution of the erection, testing and commissioning work shall be in such a manner that no interference is caused to the operation of other agencies working in the same area.

2.1.25 GUARANTEE AND PENALTIES

- (i) All the equipment supplied shall be guaranteed for quality workmanship and compliance with the specified requirements for integrated performance to deliver rated outputs.
- (ii) The Tenderer shall guarantee individual as well as integrated performance of all equipment supplied by him for a period of 12 months from the date of plant take – over by the Engineer-in-Charge.
- (iii) Equipment offered shall be guaranteed for the attainment of specified parameters during the performance of specified parameters during the performance guaranteed parameters; the Supplier shall be advised for necessary rectification work. Even after two such consecutive rectification work, if a particular equipment fails to achieve the guaranteed parameters, it will be assumed that the plant and equipment supplied is defective in its design and will be subjected to penalties. However, while levying the penalties, the applicable tolerance will be

taken into account. The expenditure incurred on account of implementing the modifications/changes shall be borne by the Tenderer/Supplier.

- (iv) The penalties for non-performance shall be discussed during tender discussions and shall be finalized as mutually agreed.
- (v) The approval of drawings and /or inspection by Engineer-in-Charge will not absolve or relieve the Supplier from any of his obligations under the contract and he shall be wholly and solely responsible for the satisfactory operation and guaranteed performance of his supply.
- (vi) The Supplier will be solely responsible and accountable for any defects and subsequent delays in supply due to re-inspection.

2.2.0 TECHNICAL SPECIFICATION – TECHNOLOGICAL / MECHANICAL WORKS

2.2.01 SOURCE OF RAW WATER:

The source of raw water shall be either from municipal supply or underground water from tube wells located within hospital complex.

2.2.02 QUALITY OF RAW WATER:

For design of water treatment, tenderer shall consider water quality of underground water from tube wells. Tenderer shall test and confirm water quality after award of work and before actual design and supply of treatment plant.

2.2.03 PROCESS OF WATER TREATMENT:

As the bore well water contains total hardness more than 240mg/l, water treatment is required to bring down the hardness level to 5 mg/l or less. The scheme of treatment shall comprise pressure sand filter followed by softener. Further provisions for disinfection shall be considered in the scheme.

2.2.04 CAPACITY OF WATER TREATMENT PLANT AND EQUIPMENT:

The tenderer shall design the treatment plant for 190m³/ day and the plant shall operate for 8hours duration.

Accordingly the water treatment plant will contain the following equipment and all other required equipments for the successful commissioning and operation of the WTP for meeting the designed capacity.

- (i) Raw water pumps – 2 nos. (1W+1S) W – Working, S – Stand by
- (ii) Pressure sand filter – 2 nos. (1W+1S)
- (iii) Sodium hypochlorite dosing system, dosing pumps, etc complete
2 nos. (1W+1S)
- (iv) Flow meters:
 - a) Electro Magnetic flow meter: 1no (1W)
 - b) Digital flow meter: 2 nos. (2W)

2.2.05 EQUIPMENT SPECIFICATIONS:

(a) RAW WATER PUMPSET

The raw water pump-sets shall be of centrifugal type with each capacity $Q=22.5\text{m}^3/\text{h}$ and $H=40\text{m WC}$ (tentative).

The material of construction of pumps shall be SS: 304.

The pump-sets shall pump raw water from raw water sump to treatment units. Tendered shall finalize the head of the pump suitable for operation of the treatment plant.

(b) PRESSURE SAND FILTER

The tentative specifications of the pressure sand filter shall be as follows:

Diameter	: 1000mm
HOS	: 2300mm
Shell thickness	: 5mm
Dish end thickness	: 5mm
Max. Flow rate	: $24\text{m}^3/\text{h}$
Average flow rate	: $24\text{m}^3/\text{h}$
Period between backwash	: 24 hours (inlet turbidity<25NTU)
Pressure for cleaning	: 0.8 Kg/cm^2
Max. Working pressure	: 3.5 Kg/cm^2
Min. Working pressure	: 1.8 Kg/cm^2
Backwash flow rate	: $31.5\text{ m}^3/\text{h}$
Source of water	: Raw Water (<25 NTU)
MOC	: MS
Type of flow	: Down flow
Internal arrangement	: Pebbles & crushed gravels and support media of mixture of multi grade sand.

Type of Valves	: Butterfly valve
Max Pressure loss	: 1.0 Kg/cm ²

Suitable backwash and overflow arrangement shall be provided by the Tenderer.

(c) SOFTENER

The tentative specification of the softener shall be as follows:

Diameter	: 1200mm
HOS	: 2500 mm
Shell thickness	: 6mm
Dish end thickness	: 6mm
Max. Flow rate	: 30m ³ /h
Average flow rate	: 24m ³ /h
Period between regeneration	: 8 hours
Max. Working pressure	: 3.5 Kg/cm ²
Min. Working pressure	: 1.8 Kg/cm ²
Regeneration tank (HDPE)	: 1000 liters capacity
Raw Water hardness	: 240ppm
Regenerate Qty, (NaCl)	: As required
Out put between Regeneration	: 180 m ²
Residual hardness	: <5 ppm
MOC	: MS internal black bituminous and external red Oxide paint
Type of Valves	: Butterfly valve

Max Pressure loss : 0.5 Kg/cm²

Brine tank Size 1200 dia x 900 deep

Suitable regeneration and waste water disposal arrangement shall also be provided by the Tenderer.

(d) SODIUM HYPOCHLORITE DOSING SYSTEM:

The tentative specification for sodium hypochlorite dosing system shall be as follows:

No. of pump : 1 No

Max. Discharge : 2.4 lph

Max. Working pressure : 4 kg/cm²

Construction details : PP Dosing Head

MOC of wet parts : PP/PVC

MOC of tank : HDPE / LDPE

Capacity of tank : 100 liters

No. of tanks : 1 no

Power consumption : as required

Piping : PVC flexible hose

Accessories included with pump : Foot valve, Dosing valve, level
Switch – one No. each

(e) DRINKING WATER PUMPSET

1. The drinking water pump-set shall be of centrifugal, horizontal or vertical type with each capacity $Q = 45\text{m}^3/\text{h}$ and $H = 35\text{ m WC}$ (tentative). The material construction of pumps shall be SS: 304.
2. The above pump set shall pump drinking water from drinking water sumps in WTP to pipe network feeding water to 2 Nos OHTs in Hospital building.

3. Suitable pressure switch or level control switch shall be provided for each pump set set for automatic stop of the pump set when the OHTs are filled up.

The above instrumentation includes supply, erection, commissioning of power and control cables from WTP pump house to 2nos OHTs at Hospital building with suitable starter panel, earthing etc.

4. Pump shall have provision both auto stop as well as manual operation.

(f) DRAINAGE PUMPSET

Provide 1no drainage pumpset including delivery line and valves in WTP room for floor drainage. The capacity of pump shall be $Q=7.5\text{m}^3/\text{h}$; $H=10\text{mWC}$ (tentative). The material construction of pumps shall be SS: 304.

(g) FLOW METERS

1. Electro magnetic flow meter: 1no (1W)) which shall be provided on the common delivery line of drinking water pumpsets. Line size: 115mm OD (4"), Flow Range: 0 to 50 m^3/h . The supply shall include all accessories and cables etc complete.
2. Economical model Digital flow meter:

The meter shall indicate rate of flow indicator and cumulative flow. 2nos(2W) shall be provided, 1 each on the Municipal water supply line and tube well water supply line to fire water sumps.

Line size : 76.6mm OD (2½"), Flow Range: 0 to 50 m^3/h . The supply shall include all accessories and cables etc complete.

2.2.06 INTER CONNECTING PIPELINES, VALVES AND FITTINGS

- (i) The individual delivery lines from the pumps shall have non-return valves and gate valves.
- (ii) Suitable number of valves shall be provided in the inter connecting pipelines for diversion and control of flows as approved by the Purchaser / Consultant.
- (iii) All pipelines shall be so arranged to avoid excessive loss of head outside the pump or disturbance of the flow within pump.
- (iv) The velocity of flow in the piping shall be generally 1.5 to 2.0 m/s.
- (v) All high points in the pipelines shall be avoided to prevent any gas accumulation.

- (vi) CI sluice valves shall conform to IS: 780.
- (vii) CI butterfly valves shall confirm to IS: 13095.
- (viii) CI non-return valves shall confirm to IS: 5312.
- (ix) All centrifugally cast (spun) iron pipes shall confirm to IS: 1536.
- (x) All cast iron flanged pipes shall confirm to IS: 1537.
- (xi) CI pipes fitting shall conform to IS: 1538.
- (xii) MS pipes /GI pipes shall conform to IS: 1239 and IS: 3589 and shall be laid as per IS: 5822.
- (xiii) CI pipes shall be laid as per IS: 3114.
- (xiv) Salt glazed stone ware pipes used shall conform to IS: 651 and shall be laid as per IS: 4127.
- (xv) RCC pipes used shall conform to IS: 458 and shall be laid as per IS: 783.
- (xvi) HDPE pipes used shall conform to IS: 4984 and shall be laid as per IS: 7634 (Part II).

2.3.0 OTHER SERVICE

The Tenderer shall provide necessary waste effluent disposal facility for the WTP. The above facilities are to be shown in the layout plan and other G.A. drawings as necessary.

2.4.0 QUALITY OF TREATED WATER

The treated water shall conform to following standards:

Parameters:

- a) Total hardness(as CaCO_3): 5 mg/1 or less
- b) Turbidity (NTU) : 1 or less
- c) E.coli : Must not be detectable in any
100 ml sample
- d) Residual chlorine : 0.2 to 0.3 mg/1

2.5.0 TECHNICAL SPECIFICATION – ELECTRICAL & INSTRUMENTATION WORKS

2.5.01 ELECTRICS

The Electrical Specification of this work is intended to cover the supply, installation, testing and commissioning of the entire electrical equipments, its instruments and all items and accessories including consumable against the lump sum price of the contract.

The equipment and accessories shall be complete in all respects and any device not included in this specification but essential for proper operation of the plant shall be deemed to be within the scope of this specification, whether specifically mentioned or not.

Some parts of the total work may tie ups with the existing system particularly mode of power supply to the Motor control centre etc, and the contractor has to get it done for the completion of this work.

The main incoming Panel Board (MCC) and instruments to cater main supply to all the motors and instruments comes under the scope of the contractor. However the incoming supply to MCC through suitable UG cable should be taken from the LT panel. From MCC to each and every motors and instruments supply will be given by the contractor. In all outdoor areas cables shall be laid mostly directly buried underground with adequate mechanical protection wherever necessary where as in indoor areas cable shall be laid in trenches /wall/ structures through suitable trays / cleats.

All allied civil works, such as foundations to motors and equipments come under the scope of the contractor. Supply of steel and cement required in the execution of the contract work shall also be the responsibility of the contractor.

All motors shall be suitable for outdoor installations with tropical insulation and protective category of IP – 54 and incase of submersible pump sets IP-68 protection should be adopted. All motors shall be started and stopped by push button at local control stations, located near the respective motors. Necessary emergency stop push button with control cabling as per the statutory requirement shall be provided.

All motors with capacity below 7.5 HP shall have Direct-On-Line starters unless otherwise specified and motors with higher capacity shall have fully automatic star / Delta starters.

Earthing system shall be carried out with GI strips, GI/ Cu wires, electrodes by GI pipes. All equipments shall have two separate and distinct earth points as per IS specifications.

Automatic power factor improvement panel with capacitor bank shall be included to maintain a power factor of 0.95 lag all the time.

All cable glands should be brass double compression type. All AL /CU cables should be terminated through crimping type AL / CU ligs respectively with earth connection to the glands.

2.5.02 INSTRUMENTATION:

All instruments such as level switch for sump, Electromagnetic Flow meter, Flow measuring device, Receiver Electronic Indicator should be of IS specification and standards. The instrumentation shall be complete in every respect and liberal to the extent of providing data of all operation variables sufficient for the safe, efficient, easy operation, easy fault diagnosis, start-up and shut down of the plant.

The design and installation of instruments shall be generally in accordance with ISA/ API recommended practices and other applicable IS standard.

All instruments and equipments shall be suitable for use in a hot, humid and tropical industrial climate in which inflammable gases may be present.

Instrument power circuits shall be individually protected from fault with the help of fuses. Power supply to the individual instrument shall be able to disconnect with the help of switch and protected with the help of fuses.

All instruments shall be electronic type Transmitters shall be “smart’ type and conventional electronic type where ‘smart’ version is not available. All electronic instruments shall be immune to Radio Frequency interferences.

Flow indicator – cum- Totalizes as well as single pen recorder shall be provided on the control panel for indicator and recording of flow rate and digital display of total flow over a period of time.

For all drives lamp indicators shall be provided on the control panel for running indicator as well as audiovisual alarms. All the instruments proposed should be as per IS specification and standard to read the correct measurements and readings.

2.5.03 DRAWINGS AND DATA

Construction of Super Speciality Hospital for Govt. Rajaji Hospital at Madurai, Tamil Nadu

The contractor shall furnish the following drawings and get the approval from the Engineer in charge before commencement of the work.

- i. General Arrangement drawing for all equipments.
- ii. Schematic Diagram.
- iii. As fitted drawing (After completion)

The contractor should also issue the Technical catalogues, and operation and maintenance manual for all vital equipments to the clients.

All Electrical Installations are to be carried out as per the statutory requirement of Chief Electrical Inspector to Govt. / Explosive Authority / IE Rules / applicable IS code / code practices for obtaining clearance from Electrical Inspectorate.

In general Data to be furnished by Tenderer along with offer and after placement of order by successful Tenderer shall follow relevant specification of this TS vide section 7.5.0 and 7.6.0.

3.0 COMMERCIAL CONDITIONS

- 3.01 The tendered rate shall inter alias be deemed to include for the provision of all materials, process, operation and special requirements detailed in the particular specification irrespective of whether these are mentioned in the description of equipment schedule and Bill of quantities or not. It is an express condition of the contract that the tendered rates for various items in the Bill of Quantities shall be deemed to include for the full, entire and final condition of the contractor respective items of the works in accordance with the provision of the contract.
- 3.02 The tendered rate shall include for all taxes, duties, etc. as applicable and shall be quoted on the works contract basis for Supply, Erection, Testing & Commissioning and Handing over of Water Treatment Plant.
- 3.03 The tendered rate shall remain firm and free from variation due to rise in the cost of materials/equipment, labour or any other reasons whatsoever during the contract period and valid extension.
- 3.04 The quantum of excise duty included in the tendered price, the rate at which they were assumed etc. shall be indicated in the tender.

3.1 UNIT RATES

Construction of Super Speciality Hospital for Govt. Rajaji Hospital at Madurai, Tamil Nadu

3.1.1 The tenderer shall indicate unit rates for quantities of various items like piping, power wiring, insulation and other relevant items.

3.1.2 Only approved work will be measured on completion and priced as per rates quoted against the respective items.

3.2 BRIEF DESCRIPTION OF PRICING

3.2.1 The tenderer shall furnish duly certified breakup of material and labour separately for each item of work. The same shall be attached separately along with the price bid.

3.3 PRO-RATA VALUE

The detailed break up of prices for various items of equipments and materials of the full system should be provided by successful tenderers within fifteen days from the date of letter of intent to facilitate the Employer for assessment and verification and to certify payment.

3.4 SALES TAX AND EXCISE DUTY

The tenderer shall clearly indicate sales tax, Excise and other duties as applicable in his offer for carrying out this work.

3.5 EXTRA ITEMS

The contractor is bound to carry out any items of work necessary for the completion of the job even though such items may not have been included in the schedule of probable quantities or rates, such items being necessary or essential for completing the job. Variation order in respect of such additional items and their quantities will be issued in writing by the Engineer-in-Charge.

All shavings, cuttings and other rubbish as it accumulates from time to time during the progress of work and on completion including that of the sub-contractors and special tradesman and all materials condemned by the Engineer in charge shall be cleared and removed from the site by the contractor without any extra charge.

All measuring steel taps, scaffolding, ladders instruments and tools that may be required for taking measurements shall be supplied by the contractor.

4.0 DATA TO BE FURNISHED BY TENDERER ALONGWITH OFFER

Construction of Super Speciality Hospital for Govt. Rajaji Hospital at Madurai, Tamil Nadu

In order to enable the Engineer-in-Charge to properly evaluate the Tenders, the following drawings / information shall be furnished with the Tender:

- (i) General arrangement (plan, elevation and sections) and data sheets of equipment / facility / plant with dimensions.
- (ii) Equipment list and individual equipment data sheets indicating the following:
 - Equipment no. and more
 - Quantity
 - Estimated weight
 - Brief specifications, dimensions, etc.
 - Services requirement
- (iii) Descriptive information catalogues, drawings, etc. of all equipment and pertinent engineering data so that Engineer-in-Charge may have full and complete knowledge/assessment of equipment offered.
- (iv) Experience list about supply and execution of similar type of plant by the Tenderer/Manufacturer.
- (v) Write-up or brochures on details of manufacturing and testing facilities in the shops of the Manufacturer/Supplier.
- (vi) List of equipment parts, total weight and weight of major items, Preliminary load data at load transfer points to be indicated.
- (vii) List of bought – out items and catalogues.
- (viii) Requirement of power and water.
- (ix) Layout of services pipelines, cabling, power supply distribution, etc. indicating terminal points.
- (x) All relevant technical parameters.
- (xi) List of commissioning and insurance spare parts and spares recommended for two years of normal operation and maintenance.
- (xii) List of tools, tackles and material handling equipment for repair and maintenance.
- (xiii) Schedule of design and engineering, submission of drawings for approval of Engineer-in-Charge, manufacture, supply/delivery, erection, testing commissioning, etc. in the form of bar chart.

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- (xiv) Write-up on quality assurance and control (QAQC) plan.
- (xv) List of drawing and documents to be submitted to the Engineer-in-Charge for approval/comments/reference and records, and records, clearly identified under each category.
- (xvi) List of electrics and instrumentations.
- (xvii) Safety interlocks and alarm annunciation schemes.
- (xviii) Instrumentation and control scheme.
- (xix) Catalogues of major instruments.
- (xx) Details of drive motors.
- (xxi) List of deviations and list of exclusions.
- (xxii) Any other relevant data/calculation and particulars which may further elucidate and project the Tenderer's experience and competence and details of the system offered.

5.0 DATA TO BE FURNISHED BY SUCCESSFUL TENDERER

5.01 GENERAL

- (i) The Contractor shall furnish a schedule of submission of drawings for approval of Engineer-in-Charge. Submission of drawings shall commence within two weeks after placement of order and shall be completed keeping in view the overall completion schedule of the project
- (ii) The Contractor shall submit detailed bar chart of all activities pertaining to contract, which will be approved by Engineer-in-Charge and will be subsequently used for review of progress.
- (iii) Detailed billing schedule shall be submitted by Contractor, which will be approved by Engineer-in-Charge and shall be subsequently followed for payment purpose against progress milestones.
- (iv) All drawings, documents, performance curves and manuals for Engineer-in-Charge approval/reference and records shall be submitted in six copies.
- (v) After erection of equipment, the Contractor shall submit one soft copy and six sets of all as-built drawings.
- (vi) All drawings shall be fully dimensioned and complete to the extent that may facilitate approval by Engineer-in-Charge in conjunction with other drawings submitted earlier by the Contractor. Cross-references with other drawings and documents shall be clearly indicated.
- (vii) All drawings shall be complete with bill of materials indicating quantity, material specification, unit and total weights and applicable standard code in respect of each item.
- (viii) Shop test certificates, test reports and curves for all items shall be submitted for scrutiny/ approval along with or before inspection call for the item.

5.02 APPROVAL OF DRAWINGS AND DOCUMENTS

- (i) After scrutiny drawings, the Engineer-in-Charge will return one copy/ set of drawings to the Contractor marked with stamp of approval. The stamping shall be in any of the following four categories:

1. Approved

2. Approved except as noted. Forward final drawing.
 3. Comments marked. Resubmission required.
 4. Not approved.
- (ii) Drawing under categories 2, 3 and 4 shall be revised to incorporate the comments and resubmitted for final approval. All revisions shall be marked on the drawings, together with date, reference and details of changes made. Reasons for not incorporating any of the comments made by the Engineer-in-Charge shall be clearly brought out to the attention of the Engineer-in-Charge while submitting the revised drawing.
- (iii) Revised drawing shall be submitted within 15 days from the date of comment on drawing by Engineer-in-Charge
- (iv) The drawings will be reviewed only for general conformity with contract requirement and specification. The approval will not relieve the Contractor of his responsibility towards adequacy and completeness of design and material and final fitment of parts sub-assemble/assembled at site for satisfactory operation of plant and equipment supplied.

5.03 DATA, DRAWINGS AND DOCUMENTS TO BE SUBMITTED

5.03.1 Immediately after Order Placement

Following drawings/documents with supporting calculations shall be submitted in six copies for approval of Engineer-in-Charge at least 60 days before scheduled date of commencement of this work.

01. List and schedule of submission of drawings.
02. Detailed QC and QA plan.
03. Calculations for sizing/selection of equipment.
04. Equipment overall dimension drawing.
05. Layout drawing, foundation plan and load data.
06. GA drawings of civil facilities, buildings, trenches, etc.
07. Water and power requirement along with electrical load data.
08. Electrical information.

5.03.2 As per Schedule Agreed with Engineer-in-Charge

Following drawings and documents shall be submitted for approval/reference at a mutually agreed date as per approved overall schedule:

- 01 Detailed specification/data sheets of equipment and auxiliaries.
- 02 Detailed drawings of all equipment and auxiliaries showing plan, sections and elevations.
- 03 Technical literature/detailed catalogues of all equipment.
- 04 P & ID and piping layout.
- 05 Electrical and instrumentation drawings.
- 06 Any revisions in drawings and documents indicated at item no. 7.6.03.01
- 07 Dispatch sequences of all items
- 08 Final list of drawings.
- 09 Final list of special tools & tackles.
- 10 Final list of consumables and spares.
- 11 As-built drawings as applicable.
- 12 Test certificates.
- 13 Other data/documents as considered necessary for proper up keep and operation of the plant and equipment and as may have been called for in the general conditions of the contract.

5.04 OPERATION AND MAINTENANCE MANUALS

The Contractor shall furnish 3 sets of operation and maintenance instruction manuals meeting the following requirements:

- (i) Instruction manuals shall present the following basic categories of information in practical, complete and comprehensive manner prepared for use by operating and/or maintenance personnel.
 1. Instruction for initial installation.

2. Instructions for operation, maintenance and repair.
 3. Recommended inspection points and periods of inspection.
 4. Ordering information for all replaceable parts.
 5. Lubrication chart.
- (ii) Information shall be organized in a logical and orderly sequence. A general description of the equipment including significant technical characteristics shall be included to familiarize operating and maintenance personnel with the equipment.
 - (iii) Necessary drawings and/or other illustrations shall be included on copies of appropriate certified drawings shall be bound in the manual. Test, adjustment and calibration information, as appropriate, shall be included and shall be identified to specific equipment.
 - (iv) A parts list shall be included showing nomenclature, manufacture's parts number and /or other information necessary for accurate identification and ordering of replaceable parts.
 - (v) Instructions and parts list shall be clearly legible and prepared on good quality paper. Instruction manuals shall be securely bound in durable folders.
 - (vi) If a standard manual is furnished covering more than the specific equipment purchased, the applicable model (or other identification) number, parts number and other information for the specific equipment purchased shall be clearly identified.
 - (vii) Instruction manuals shall include list of all special tools and tackles furnished with complete drawings and instructions for use.

SECTION III

SEWAGE TREATMENT PLANT

1.0 SPECIAL CONDITIONS

1.1. EXECUTION OF WORK

The whole of the work as described in the contract (including bills of materials, specification and all drawings pertaining thereto) and as advised by the Employers from time to time is to be carried out and completed in full to the entire satisfaction of the Employers. Any minor details of construction which are obviously and fairly intended, or which may not have been definitely referred to in this contract, but which are usual construction practice and essential to the work, shall be included in this contract.

1.2. MAINTENANCE & TRAINING FOR PERSONNEL

- 1.2.1 The contractor shall without any extra cost carry out for a period of 12 months after the installation is taken over by the owners, all routine and special maintenance and attend to any difficulties and defects that may arise in the operation of Sewage Treatment Plant.
- 1.2.2 The contractor shall associate with the Employers' staff during erection and the maintenance period, in the maintenance/operation of the Sewage Treatment Plant.
- 1.2.3 If required, by the Employers, the contractor shall also train members of the Employers' staff at their works/service station without any extra charge.

1.3. CERTIFICATE OF COMPLETION

- 1.3.1 The contractor shall intimate to HLL in writing as and when the works are completed and put into beneficial uses in order to enable HLL to check certify to take over the plants.
- 1.3.2 The work shall not be considered as completed and put into beneficial use until HLL have certified in writing that the same has been completed and put into beneficial use.
- 1.3.3 The defects liability period shall commence from date of such completion or any specific date mentioned therein.

1.4. OPERATIONAL AND MAINTENANCE MANUALS

- 1.4.1 The contractor shall also furnish the prints of all up-dated handing over along with required set of operating/maintenance manuals / instructions.

- 1.4.2 The Agency/contractor shall ensure adequate and prompt after sales service in the form of maintenance personnel and spares as and when required ensuring that all spares are easily available during the normal life of the installation. Every effort shall be made to provide zero defect performance during the guarantee period of 12 months (DLP) by undertaking preventive maintenance.

2.0 TECHNICAL INSTRUCTION TO TENDERER

2.01 SCOPE OF WORK

The tenderer's scope of work shall cover the following:

Design and engineering of the following:

- a) The complete system of STP consisting mainly coarse screen chamber, sewage lift pump house, fine screen chamber, grit channels, equalization tank, sewage distribution pit, aeration tanks, secondary setting tanks, sludge pump house, sludge digester and drying beds, parshall flume flow measuring structure and other required facilities.
- b) Tertiary treatment plant for further treating the clarified effluent from secondary settling tanks consisting filter feed sump, pressure sand filter, activated carbon filter, disinfection system using sodium hypochlorite solution, treated/reclaimed water sump, all pumping systems, etc complete.
- c) STP Electrical Panel Room for power supply to all the MCCs inside STP area.
- d) Suitably pretreatment facilities for hospital laboratory effluents comprising neutralization pit, chemical dosing system with pH monitor and control, propeller type agitator in the neutralization pit, etc. complete.
- e) All civil works for STP including plant roads, foot paths, fencing and entry gate, etc, complete.
- f) All electrical work for STP consisting of STP Electrical panel, MCC, ultrasonic liquid level controller, local push button controls, ventilation fans, all power and control cables from MCC onwards, etc. complete.
 - Ultrasonic type flow recording device at flume structure.
 - Necessary instrumentation required for smooth running of STP.
 - Necessary illumination of pump houses, treatment units and entire plant area.
- g) Necessary material handling facilities for all pump houses and tertiary treatment plant.

- 2.02** Manufacture, procurement, assembly, shop testing, surface preparation, shop painting, packing, supply at site, storing at site for all equipment/items.
- 2.03** Erection of equipment at site.
- 2.04** Finish paint of equipment at site after erection.
- 2.05** Testing and commissioning of the equipment and whole treatment plant.
- 2.06** Demonstration of performance guarantee.
- 2.07** Furnish all drawings, documents, load data and other information / data like fault diagnosis, operation and maintenance manual, etc., general arrangement and layout drawings, design calculations and equipment specifications, together with as built drawings for all mechanical and electrical installations.
- 2.08** All civil works design and construction including general structural works. All technological structures, supports for equipment, etc. complete.
- 2.09** Supply of spares for normal operation and maintenance of equipment for a period of 2 years to be reckoned from the date of taking over of the equipment by the client.

A list of spares shall be indicated in the offer and these spare parts shall be supplied to the client's store at site prior to commission of the equipment. No equipment shall be taken over by the client until these spares are supplied. The Tenderer will be required to replenish at his own expense the stock of spares used up during the performance test and within guarantee period.
- 2.10** The Tenderer shall include in the scope, the requirement of all lubricants, and other consumables for testing, commission and performance guarantee runs.
- 2.11** The Tenderer shall list out in offer and provide a complete new and unused set of all special tools and tackles required for operation and maintenance of equipment. Necessary material handling equipment shall also be part of these tools.
- 2.12** All necessary foundation bolts, puddle flanges, matching flanges and anchoring parts shall be in the scope of the Tenderer.
- 2.13** Any additional work / equipment and material which may not be specially mentioned in the specification but are required to make the equipment complete in every respect in accordance with technical specification and necessary for safe operation and guaranteed performance of the plant shall be covered and provided by the tenderer.

2.14 The tenderer shall consider in their scope for supply and laying of 10m length each for inlet sewer line and final reclaimed waterline, and also quote unit rate for the same.

2.15 The Tenderer shall assist the Client for obtaining the clearance from State Pollution Control Board and other statutory agencies concerned. The Tenderer will assist the Client for obtaining “No Objection certificate” and “Consent for discharge of effluents” from the State Pollution Control Board.

2.16 WORKMANSHIP AND QUALITY CONTROL

- i) The equipment supplied shall be new and best of their kind and of latest technology. All materials and equipment shall comply with the latest Indian standards and statutory requirements of the concerned State Governments. In absence of relevant Indian standards / practices, any other international standards acceptable to the Engineer-in-Charge may be followed, but the same shall be clearly brought out in the offer.
- ii) The equipment shall be designed to have maximum reliability and ease of operation and maintenance.
- iii) The Tenderer shall avoid offering sophisticated and complicated equipment where simple and proven equipment will achieve the specified requirements.
- iv) Quality assurance plan shall be furnished after placement of order.

2.17 CODES AND STANDARDS

- (i) All equipment supplied shall be in conformity with applicable codes and standards. All codes and standards used/referred to shall be to their latest edition /version as on the date of the acceptance of the tender.
- (ii) All equipment shall conform to the provision of statutory and other regulations in force, such as Indian Explosive Act, Indian Factories Act, etc.
- (iii) All electrical equipment shall comply with the latest revision of Indian Electricity Rules and within the statutory requirement of the Government of India and State Government as regards safety, earthing and other provision specified therein for installation and operation of electrical equipment.

2.18 DEVATION, ASSUMPTION AND ALTERNATIVE PROPOSALS

- (i) The deviations from specification in any respect shall be clearly defined and indicated by the Tenderer along with reasons in the offer. In case of

no list of deviations submitted by the Tenderer, all requirement and provisions of the specification shall be automatically deemed to have been agreed and complied by the Tenderer.

- (ii) Any assumption made for calculations or working out details shall be indicated in the offer clearly by the Tenderer.
- (iii) The Tenderer shall submit an offer which complies with the technical specification. However, the Tenderer, if desires, can submit in addition and alternative offer for a design which may differ from specification. However, the Tenderer, if desires, can submit in addition an alternative offer for a design which may differ from specification. Such alternative would be given careful consideration provided that adequate supplementary information drawings and data are submitted to permit a complete evaluation of the offer made.

2.19 PAINTING

- (i) All ferrous metal works shall be provided with corrosion resistant paint treatment applied in accordance with the best trade practice suitable for plant and equipment.
- (ii) The paints shall be obtained from reputed manufacturer. The formulation and application procedure shall be as per recommendation of the manufacturer for appropriate exposure conditions.
- (iii) Final / touch-up painting shall be done at site after erection of equipment.
- (iv) In case the equipment operating conditions require any other special painting, the Supplier shall indicate the same in the offer.

2.20 IDENTIFICATION MARKING

- (ii) Flow direction shall be marked on the various fluids piping in contrast colour shade.
- (iii) Equipment part number/name shall be marked on all equipment parts and machinery. Match-marks, wherever necessary, shall be provided for facilitating erection.

2.21 INSPECTION AND WORKS TESTING

- (i) The plant and equipment will be subjected to inspection and witnessing of tests by the Engineer-in-Charge. The supplier shall inform the Purchaser/his Consultants at least fifteen days in advance of the date when the plant and equipment will be made available for shop inspection and testing.

- (ii) The Engineer-in-Charge shall be allowed to use free of cost all the testing facilities available with the Manufacturer for the purpose of testing.
- (iii) Necessary test, for which adequate facilities are not available with the Supplier/sub-contractor, will be carried out at mutually agreed testing laboratories at the cost of contractor.
- (iv) Inspection and works testing shall be carried out based on approved drawings and specifications and as per relevant standards.
- (v) A copy of the order on the sub-suppliers, comprising all the detailed specification and bill of materials shall be provided to the Purchaser along with or before inspection call.
- (vi) The Supplier shall inspect the equipment/part before offering to the Engineer-in-Charge for inspection and satisfy himself with regard to the quality and quantity and issue an internal inspection certificate along with manufacturer's test certificate to the Engineer-in-Charge.
- (vii) The Supplier shall not dispatch the materials from his works unless it has been inspected, tested and accepted by the Engineer-in-Charge unless specific approval for the same is given by Engineer-in-Charge. In either case, the material shall be dispatched by Supplier only after issue of dispatch clearance by Engineer-in-Charge.
- (viii) The Engineer-in-Charge shall have the full right to accept or reject the materials, if during inspection and testing, the materials are found not conforming to specification and/or standard.
- (ix) Inspection by the Engineer-in-Charge shall not relieve the Supplier of his liability for rectifying defects which may subsequently appear or be detected during or after erection. After rectification, the testing of the plant and equipment shall be repeated to the satisfaction of the Engineer-in-Charge.

2.22 PACKING, DISPATCH, HANDLING & TRANSPORTATION

- (i) Packing and weather proofing shall be subject to approval of the Engineer-in-Charge. This approval will be general and may not be required every time for an article or group of articles to be dispatched. However, the Engineer-in-Charge reserves the right to examine the packing for any particular consignment at Supplier's / Manufacturer's works before dispatch.
- (ii) The Supplier shall be entirely responsible for the insurance, shipment, handling and transportation of all equipment, construction tools,

labourers and materials including unloading at destination, transporting to site, off-loading, storing and protection at site till erection.

2.23 ERECTION, TESTING & COMMISSIONING

- (i) The equipment supplied shall be erected, tested and commissioned individually as well as for integrated operation.
- (ii) All site tests on plants shall also subject to prior approval by Engineer-in-Charge. The Supplier/Contractor shall submit to Engineer-in-Charge or his representative the list of pre-commissioning tests intended to be carried out. This list will be reviewed and finalized before commencement of tests.
- (iii) The tests shall be carried out as per mutually agreed schedule so that they may be witnessed by Engineer-in-Charge.
- (iv) The execution of the erection, testing and commission work shall be in such a manner that no interference is caused to the operation of other agencies working in the same area.

2.24 GUARANTEE AND PENALTIES

- (i) All the equipment supplied shall be guaranteed for quality workmanship and compliance with the specified requirements for integrated performance to deliver rated outputs.
- (ii) The Tenderer shall guarantee individual as well as integrated performance of all the equipment supplied by him for a period of 12 months from the date of plant take-over by the Engineer-in-Charge.
- (iii) Equipment offered shall be guaranteed for the attainment of specified parameters during the performance of specified parameters during the performance guaranteed parameters; the tenderer shall be advised for necessary rectification work. Even after two such consecutive rectification works, if a particular equipment fails to achieve the guaranteed parameters, it will be assumed that the plant and equipment supplied is defective in its design and will be subjected to penalties. However, while levying the Penalties, the applicable tolerance will be taken into account. The expenditure incurred on account of implementing the modifications/changes shall be borne by the Tenderer.
- (iv) The penalties for non-performance shall be discussed during tender discussions and shall be finalized as mutually agreed.

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- (v) The approval of drawings and /or inspection by Engineer-in-Charge will not absolve or relieve the tenderer from any of his obligations under the contract and he shall be wholly and solely responsible for the satisfactory operation and guaranteed performance of his supply.
- (vi) The tenderer will be solely responsible and accountable for any defects and subsequent delays in supply due to re-inspection.

3.0 TECHNICAL SPECIFICATION – TECHNOLOGICAL / MECHANICAL WORKS

3.01 TYPE OF TREATMENT PLANT

- (i) The Tender shall provide Fluidized Bio Reactor (FBR) type sewage treatment plant for secondary treatment of sanitary and faecal sewage from the proposed hospital. Further the STP shall have provision for tertiary treatment of secondary clarified effluent to produce reclaimed water for landscaping and other uses.
- (ii) The STP shall comprise coarse screen chamber, sewage, lift pump house, fine screen chamber, grit channels, equalization tank, distribution pit, aeration tanks, secondary settling tanks, sludge pump house, sludge digester and drying beds, parshall flume flow measuring structure, filter feed sump, pressure filter, activated carbon filter, sodium hypochlorite dosing system, reclaimed water sump, pumping machineries, electrical panel room and other required facilities. Further pretreatment facility for hospital laboratory effluents shall be separately provided at the lab area of hospital.

3.02 DESIGN CAPACITY

- (i) The Tenderer shall design the STP for $7.125\text{m}^3/\text{h}$ (average flow) with 400mg/l BOD_5 at 20°C organic loading.
- (ii) Peak flow for design of raw sewage pumping shall be considered as $22\text{m}^3/\text{h}$.
- (iii) The Tenderer shall provide three streams of aeration tank and settling tank with 50% average design capacity each, i.e. the STP shall have 150% capacity with all three streams working and shall have 100% capacity with two streams working.

3.03 TREATMENT UNITS

The dimensions / sizes and levels of various treatment units given in the followings specification are tentative only. The Tenderer shall provide dimensions / sizes of treatment units based on detailed calculations and actual site condition as approved by the Engineer-in-Charge.

3.04 COARSE SCREEN CHAMBER

- (i) The raw sewage from hospital sewerage network shall enter the coarse screen chamber. The inlet sewer line shall be of 150mm dia SW pipe.

- (ii) The coarse screen chamber shall have an overall area of 4.00 m x 1.20 m.
- (iii) Suitable fixed types SS bar screen shall be provided with screen opening of 25 mm clear.
- (iv) PVC step shall be provided for access into the chamber for cleaning and maintenance.
- (v) Suitable hand railing shall be provided around the coarse screen chamber.

3.05 SEWAGE LIFT PUMP HOUSE

The sewage lift pump house shall have sewage sump and pump room above FGL. Submersible sewage pump sets shall be placed inside the sump and the pump room shall accommodate MCC, delivery pipelines, valves and fittings, suitable ultrasonic liquid level controller, lifting facilities for sewage pump sets. The sewage pump house shall have suitable illumination and mechanical ventilation facilities. Suitable door and window shall be provided for the pump house.

a) Sewage Sump

- (i) The sewage sump shall have suitable capacity not greater than 30 min detention for the lowest rate of pumping.
- (ii) The sewage sump shall have suitable access opening in the pump room floor slab and PVC step provision for access inside the sump.

b) Pump Room

The pump room have sewage sump and shall accommodate individual delivery lines and common header with all valves and fittings. A suitable monorail with chain pulley block shall be provided and shall be capable of lifting the heaviest component of the pumping systems. Further suitable mechanical verification facilities using exhaust fans shall be provided. Suitable magnetic flow meter shall be provided for measuring the rate and cumulative flow of the raw sewage pumped to the treatment plant.

3.06 RAW SEWAGE PUMPSETS

- (i) 2 Nos. submersible type pump sets with one working and the other stand by shall be provided.
- (ii) Each pump shall have capacity 22m³/h with suitable head.
- (iii) Pumps shall be of non-clog type handling domestic sewage.
- (iv) Pump shall have impeller in SS 304 and shaft in SS 410 material as approved by the Engineer-in-Charge.

- (v) Pump shall have manual control in addition to automatic liquid level control using ultrasonic sensor.
- (vi) The automatic liquid level control will be such that the working pump shall start when the liquid level in the sewage sump reaches a preset high level and it shall stop when the liquid level falls to a preset low level.

3.07 FINE SCREEN CHAMBER

- (i) Sewage lift pump house shall discharge the sewage to fine screen chamber.
- (ii) Suitable fine screen chamber shall be provided
- (iii) Suitable fixed type SS bar screen shall be provided with screen opening 16 mm clear.
- (iv) Suitable MS ladder shall be provided for access to the fine screen chamber.

3.08 GRIT CHANNELS WITH PROPORTIONAL FLOW WEIR

- (i) 2 Nos. Grit channels shall be provided with one working and the other standby.
- (ii) Proportional flow weir shall be provided at the end of each grit channel to maintain grit settling velocity about 0.3m/s at average flow and 0.9 m/s at peak flow.
- (iii) The bottom of the grit channel shall have space for accumulation of grit and also drain pipe with butterfly valve for removal of grit material periodically once in a week.
- (iv) Each grit channel shall have two numbers slide gates on either ends and slide gates shall be CI or aluminum material.

3.09 EQUALIZATION TANK

- (i) Provide 1 No equalization tank with 2 hour detention time for peak flow condition.
- (ii) Suitable diffused aeration shall be provided at the bottom of equalization tank to avoid settlement of solids.

3.10 FLOW DISTRIBUTION CHAMBER

- (i) Suitable semicircular sewage flow distribution chamber shall be provided at the end of equalization tank.
- (ii) HDPE pipe with CI Butterfly valve shall be provided to discharge the sewage from distribution pit to aeration tanks.

3.11 AERATION TANKS

- (i) 3 Nos. aeration tanks shall be provided in parallel with 50% capacity each.
- (ii) FBR volume required shall be 1.5kg BOD/ d/m³ for design of aeration tank.
- (iii) Media BOD loading rate shall be 20g of BOD/d/m² of media surface area.
- (iv) Oxygen requirement of 2 Kg / Kg BOD applied shall be adopted for diffused aeration.
- (v) The side wall of the aeration tank shall have suitable protection hand railing.
- (vi) 3Nos air blowers shall be provided in the blower room located in the tertiary treatment plant for supply of diffused aeration to aeration tanks (3), equalization tank (1) and reclaimed water sump.

3.12 SECONDARY SETTLING TANKS

- (i) 3 Nos. secondary setting tank shall be provided in parallel.
- (ii) The settling tank shall be designed for 0.5m³ / m²/h surface loading rate and 2.5 hr detention time.
- (iii) The hopper slope shall be 45° or as approved during detailed engineering.
- (iv) The settling tank shall have suitable inlet and overflow launder arrangement.
- (v) The settling tank shall have suitable protective hand railing.
- (vi) The settling tank shall have suitable access ladder from FGL.

3.13 SLUDGE RECIRCULATION PUMP HOUSE

- (i) A sludge pump house shall be provided to accommodate 3 Nos. sludge pumps, one number for each stream. Sludge pump shall receive sludge from hopper bottom settling tank.
- (ii) Each stream shall have 1 No. sludge pump set (1W) for sludge pumping to sludge digester.
- (iii) The suitable capacity of each pump set with suitable head to be provided.
- (iv) The pump shall be non-clog type with SS impeller and shaft.
- (v) The sludge pump house shall accommodate MCC for control of sludge pumpsets.
- (vi) The sludge pump house shall be provided with suitable door and windows.

- (vii) Suitable mechanical ventilation using exhaust fans shall be provided for the sludge pump house.
- (viii) Suitable material handling facility with chain pulley block and monorail shall be provided for handling the sludge pumps.

3.14 SLUDGE DIGESTER

- (i) Provide 1 No anaerobic sludge digester with retention time of 365days for digested sludge. However provided a minimum volume of 50m³.
- (ii) The digester sludge from the digester shall be withdrawn and dried in sludge drying beds.

3.15 SLUDGE DRYING BEDS

- (i) 2 Nos. sludge drying beds shall be provided with suitable area.
- (ii) 20 cm sludge depth and 10 days drying period shall be adopted for designing the sludge drying beds.
- (iii) The sludge drying bed shall have suitable depth of sand and gravel bed as per CPHEEO sewage manual and as approved by the purchaser.
- (iv) The sludge drying beds shall have suitable sludge distribution system with sludge channels and control slide gates of Aluminium materials.
- (v) Suitable drain pipe system below sludge drying beds shall be provided using loose joined SW pipes and filtrate drainage shall be connected to raw sewage lift pump house by gravity line.
- (vi) Sludge drying beds shall be covered with suitable shed having poly carbonate roof sheet. The sides of shed shall be kept open to allow natural ventilation.

3.16 PARSHALL FLUME FLOW MEASURING STRUCTURE

- (i) Suitable parshall flume flow measuring structure shall be provided to measure the flow of clarified effluent from secondary settling tanks to tertiary treatment plant.
- (ii) Ultrasonic type flow measuring system shall be provided to recording rate of flow as well as cumulative flow. Necessary electronics and digital display shall be housed inside Tertiary treatment plant.
- (iii) The parshall flume shall be designed for a maximum flow measurement of 60m³/h.

3.17 TERTIARY TREATMENT PLANT & BLOWER ROOM

- (i) The secondary clarified effluent from secondary settling tank shall be received in a filter feed sump of 8 hours capacity, also provision for disinfection using sodium hypochlorite dosing system shall be made before filtration.

The effluent shall be filtered using pressure sand filter and then passed through activated carbon filter. The activated carbon filtered effluent shall be disinfected using sodium hypochlorite dosing system before receiving in a reclaimed water sump of 1 day capacity.

There shall 2 Nos. of stream of equipment with one working and other stand by as follows.

- a) Filter feed pumps 2 Nos. (1W + 2S) (W- Working; S – Stand by)
- b) Pressure sand filters 2 Nos. (1W+ 1S)
- c) Activated carbon filters 2 Nos. (1W + 1S)
- d) Sodium hypochlorite dosing system 2 Nos. (1W+1S)
- e) Reclaimed water pumpsets 2 Nos. (1W+1S)

The above equipment and system shall be suitable designed for 20 hours duration of operation.

- (ii) The tertiary treatment plant including blower room of appropriate size. The filter feed sump and reclaimed water sump shall be below FGL, and treatment plant and blower room above FGL.
- (iii) The blower room accommodates 3 No blowers, compressed air piping and MCC for blowers.
- (iv) The tertiary treatment plant and blower room shall have suitable door and windows.
- (v) Further the tertiary treatment plant and blower room shall have suitable material handling facility with chain pulley block and monorail.
- (vi) Suitable mechanical ventilation facilities using exhaust fans shall be provided for the plant room and blower room.

3.18 INTER CONNECTING PIPELINES, VALVES AND FITTINGS

- (i) The individual delivery lines from the pumps shall have non-return valves and gate valves.
- (ii) Suitable number of valves shall be provided in the inter connecting pipelines for diversion and control of flows as approved by the Engineer-in-Charge.
- (iii) All pipelines shall be so arranged to avoid excessive loss of head outside the pumps or disturbance of the flow within pump.
- (iv) The velocity of flow in the piping shall be generally 1.5 to 2.0 m/s

- (v) All high points in the pipelines shall be avoided to prevent any gas accumulation.
- (vi) CI Sluice valves shall confirm to IS:780 class-1
- (vii) CI Butterfly valves shall confirm to IS: 13095.
- (viii) CI non-return valves shall confirm to IS: 5312.
- (ix) MS pipes / GI pipes shall confirm to IS: 1239 and IS: 3589 and shall be said as per IS: 5822.
- (x) Salt glazed stone ware pipes used shall confirm to IS: 651 and shall be laid as per IS: 4127.
- (xi) RCC pipes used shall confirm to IS: 458 and shall be laid as per IS: 783.
- (xii) HDPE pipes used shall confirm to IS 4984.

3.19 OTHER SERVICE

The tenderer shall provide necessary storm water drains, plant roads, pavement / foot paths, drinking water lines and drainage platforms, toilet facility, fencing and entry gate for the STP. The above facilities are to be shown in the layout plan and other G.A. drawings as necessary.

3.20 PRETREATMENT FACILITY FOR HOSPITAL LABORATORY EFFLUENTS

- (i) Process Description:

The laboratory section of the hospital will discharge various chemical effluents and which require pretreatment before discharging to domestic sewerage.

These chemical effluents from the hospital building shall be collected separately in neutralization pits 2 Nos. (1W+1S). Each neutralization pit shall have capacity to receive effluents for 1 shift operation of laboratories. At the end of each shift pH of the effluent shall be monitored and required chemicals shall be continuously added. There shall be agitator mounted on the neutralization pit for proper mixing of the effluent. When the pH of the effluent reaches to neutral range (say pH around 7) the addition of chemical shall be stopped automatically. Then the neutralized effluent is let out to the sewer line by opening the outlet valve of the pit.

- (ii) The following points shall be considered for providing neutralization facility:
 - a) Each neutralization pit shall have mechanical agitator mounted over the pit for proper mixing of effluent. The agitator shall be of acid resistant material.

The pit shall have suitable acid proof lining, otherwise suitable synthetic or PVC tank shall be provided.

- b) Provision of dosing chemicals and dosing pumps 2 Nos. (1W + 1S) shall be provided.
- c) Automatic pH monitor and control system shall be provided for operation of dosing pumps.
- d) Inlet and piping of the neutralization pit shall have suitable control valves of PVC or acid resistant material.

3.21 QUALITY OF SECONDARY CLARIFIED EFFLUENT

The secondary clarified effluent leaving the secondary settling tank shall conform to effluent discharge standards as required by Central and State Pollution Controls Boards, and other statutory agencies.

The effluent quality shall be:

- a) BOD₅ at 20⁰ c : 20 mg/l or less
- b) Total S.S : 30 mg/l or less

3.22 QUALITY OF RECLAIMED WATER

The quality of reclaimed water shall be fit for landscape and gardening uses.

The quality of effluent shall be:

- a) BOD₅ at 20⁰ c : 10 mg/l or less
- b) Total SS solid : less than 10 mg/l
- c) Residual chlorine : 0.1 mg/l
- d) Faecal coliform : not more than 1000/ 100 ml

4.0 TECHNICAL SPECIFICATION – CIVIL WORKS

All the civil construction works shall be in general conform to the CPWD specification. The civil structures shall be designed as per latest and modified design standards and shall implement the Seismic standard and code also.

The drawings and design details shall be furnished to the consultants prior to implementation and construction.

The contractor shall be responsible for all designs and providing civil and structural drawings.

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All the underground structure like sumps and walls shall be provided with R.CC M 25 / M 30 grade concrete, and water proofing shall be carried out wherever required. The inner dimensions of each structure shall be as per TS – Technological works. Any variation or changes shall be carried out on written confirmation from the Engineer-in-Charge.

The entire cost of civil works shall include cost of civil construction, design details and providing all necessary construction drawings in hard copy and soft copy as per relevant specification in this T.S. vide section 6.0 and section 7.0.

5.0 TECHNICAL SPECIFICATION - ELECTRICAL & INSTRUMENTATION WORKS

5.01 ELECTRICAL

The Electrical Specification of this work is intended to cover the supply, installation, testing and commissioning of the entire electrical equipments, its instruments and all items and accessories including consumable against the lump sum price of the contract.

The equipment and accessories shall be complete in all respects and any device not included in this specification but essential for proper operation of the plant shall be deemed to be within the scope of this specification, whether specifically mentioned or not.

Some parts of the total work may tie ups with the existing system particularly mode of power supply to the Motor control centre etc, and the contractor has to get it done for the completion of this work.

The main incoming Panel Board (MCC) and instruments to cater main supply to all the motors and instruments comes under the scope of the contractor. However the incoming supply to MCC through suitable UG cable will be taken from the LT panel. From MCC to each and every motors and instruments supply will be given by the contractor. In all outdoor areas cables shall be laid mostly directly buried underground with adequate mechanical protection wherever necessary whereas in indoor areas cable shall be laid in trenches / wall / structures through suitable trays /cleats.

All allied civil works, such as foundations to motors and equipments come under the scope of the contractor. Supply of steel and cement required in the execution of the contract work shall also be the responsibility of the contractor.

All motors shall be suitable for outdoor installations with tropical insulation and protective category of IP – 54 and incase of submersible pump sets IP – 68 protections should be adopted. All motors shall be started and stopped by push button at local control stations, located near the respective motors.

All motors with capacity below 10 HP shall have Direct-On-Line starters unless otherwise specified and motors with higher capacity shall have fully automatic star / Delta starters.

Earthing system shall be carried out with GI strips, wires, electrodes by GI pipes. All equipments shall have two separate and distinct earth points as per IS specifications.

Automatic power factor improvement panel with capacitor bank shall be included to maintain a power factor of 0.92 lag all the time.

All cable glands should be brass double compression type. All AL / CU cables should be terminated through crimping type AL/CU lugs respectively with earth connection to the glands.

Indoor lighting points shall be carried out with M.S conduit pipe with FRLS copper wires and the light fittings with fluorescent lamps so as to have required lumen level in the pump house and control room and other areas specified in NBC.

5.02 INSTRUMENTATION:

All instruments such as level switch as level switch for sump, Electromagnetic Flow meter, Flow measuring device, Receiver Electronic Indicator should be of IS specification and standards. The instrumentation shall be complete in every respect and liberal to the extent of providing data of all operation variables sufficient for the safe, efficient, easy operation, easy fault diagnosis, start up and shut down of the plant.

The design and installation of instruments shall be generally in accordance with ISA / API recommended practices and other applicable IS standard.

All instruments and equipments shall be suitable for use in a hot, humid and tropical industrial climate in which inflammable gases may be present.

Instrument power circuits shall be individually protected from fault with the help of fuses. Power supply to the individual instrument shall be disconnect able with the help of switch and protected with the help of fuses.

All instruments shall be electronic type Transmitters shall be "smart" type and conventional electronic type where "smart" version is not available. All electronic instruments shall be immune to Radio Frequency interferences.

Inlet flow and Effluent outlet flow – rate measurements in open channel will be done by flume and ultrasonic level sensing instruments. Flow indicator-cum-Totalizes as well as single pen recorder shall be provided on the control panel for indicator and recording of flow rate and digital display of total flow over a period of time.

For all drives except aerators lamp indicators shall be provided on the control panel for running indicator as well as audiovisual alarms. There will be three lamps for each aerator. RED for running GREEN for stop and AMBER for overload trip indications.

Flow-rate measurement for recirculation sludge to Aeration Tank shall be carried out with the help of magnetic flow meter.

All the instruments proposed should be as per IS specification and standard to read the correct measurements and readings.

5.03 DRAWINGS AND DATA

The contractor shall furnish the following drawings and get the approval from the Engineer in charge before commencement of the work.

- (i) General Arrangement drawing for all equipments.
- (ii) Schematic Diagram.
- (iii) As fitted drawing (after completion)

The contractor should also issue the Technical catalogues, and operation and maintenance manual for all vital equipments to the clients.

All Electrical Installations are to be carried out as per the statutory requirement of local Electrical Inspectorate / Explosive Authority / IE Rules / applicable IS code / code practices for obtaining clearance from Electrical Inspectorate.

In general Data to be furnished by Tenderer along with offer and after placement of order by successful Tenderer shall follow relevant specification of this TS vide section 6.0 and 7.0.

6.0 COMMERCIAL CONDITIONS

6.01 The tendered rate shall inter alias be deemed to include for the provision of all materials, process, operation and special requirements detailed in the particular specification irrespective of whether these are mentioned in the description of equipment schedule and Bill of quantities or not. It is an express condition of the

contract that the tendered rates for various items in the Bill of Quantities shall be deemed to include for the full, entire and final condition of the contractor respective items of the works in accordance with the provision of the contract.

6.02 The tendered rate shall include for all taxes, duties, etc. as applicable and shall be quoted on the works contract basis for Supply, Erection, Testing & Commissioning and Handing over of Sewage Treatment Plant (STP) for Super Specialty Hospital, Govt. Rajaji Medical College, Madurai, Tamil Nadu.

6.03 The tendered rate shall remain firm and free from variation due to rise in the cost of materials/equipment, labour or any other reasons whatsoever during the contract period and valid extension.

6.04 The quantum of excise duty included in the tendered price, the rate at which they were assumed etc. shall be indicated in the tender.

6.1 UNIT RATES.

6.1.1 The tenderer shall indicate unit rates for quantities of various items like piping, power wiring, insulation and other relevant items.

6.1.2 Only approved work will be measured on completion and priced as per rates quoted against the respective items.

6.2 BRIEF DESCRIPTION OF PRICING

6.2.1 The tenderer shall furnish duly certified breakup of material and labour separately for each item of work. The same shall be attached separately along with the price bid.

6.3 PRO-RATA VALUE

The detailed break up of prices for various items of equipments and materials of the full system should be provided by successful tenderer within fifteen days from the date of letter of intent to facilitate the Employer / Purchaser for assessment and verification and to certify payment.

6.4 SALES TAX AND EXCISE DUTY

The tenderer shall clearly indicate sales tax, Excise and other duties as applicable in his offer for carrying out this work.

6.5 EXTRA ITEMS

The contractor is bound to carry out any items of work necessary for the completion of the job even though such items may not have been included in the schedule of probable quantities or rates, such items being necessary or

essential for completing the job. Variation order in respect of such additional items and their quantities will be issued in writing by the Employer /Purchaser.

All shavings, cuttings and other rubbish as it accumulates from time to time during the progress of work and on completion including that of the sub-contractors and special tradesman and all materials condemned by the project engineer shall be cleared and removed from the site by the contractor without any extra charge.

All measuring steel taps, scaffolding, ladders instruments and tools that may be required for taking measurements shall be supplied by the contractor.

6.6 TERMS OF PAYMENT

6.6.1 For equipments delivered and sorted at the site for the installation, the payment will be made by the HLL in accordance of this contract.

7.0 DATA TO BE FURNISHED BY TENDERER ALONGWITH OFFER

In order to enable the Engineer-in-Charge to properly evaluate the Tenders, the following drawings/information shall be furnished with the Tender.

- (i) General arrangement (plan, elevation and sections) and data sheets of equipment / facility / plant with dimensions.
- (ii) Equipment list and individual equipment data sheets indicating the following:
 - Equipment no. and name
 - Quantity
 - Estimated weight
 - Brief specifications, dimensions, etc.
 - Services requirement
- (iii) Descriptive information catalogues, drawings, etc. of all equipment and pertinent engineering data so that Engineer-in-Charge may have full and complete knowledge / assessment of equipment offered.
- (iv) Experience list about supply and execution of similar type of plant by the Tenderer/ Manufacturer.

- (v) Write-up or brochures on details of manufacturing and testing facilities in the shops of the Manufacturer/Supplier.
- (vi) List of equipment parts, total weight and weight of major items. Preliminary load data at load transfer points to be indicated.
- (vii) List of bought-out items and catalogues.
- (viii) Requirement of power and water
- (ix) Layout of services pipelines, cabling, power supply distribution, etc. indicating terminal points.
- (x) All relevant technical parameters.
- (xi) List of commissioning and insurance spare parts and spares recommended for two years of normal operation and maintenance.
- (xii) List of tools, tackles and material handling equipment for repair and maintenance.
- (xiii) Schedule of design and engineering, submission of drawings for purchaser's approval, manufacture, supply / delivery, erection, testing commissioning, etc. in the form of bar chart.
- (xiv) Write-up on quality assurance and control (QAQC) plan.
- (xv) List drawings and documents to be submitted to the Engineer-in-Charge for approval / comments/references and records, clearly identified under each category.
- (xvi) List of electrics and instrumentations
- (xvii) Safety interlocks and alarm annunciation schemes.
- (xviii) Instrumentation and control scheme.
- (xix) Catalogues of major instruments.
- (xx) Details of drive motors.
- (xxi) List of deviations and list of exclusions.
- (xxii) Any other relevant data/calculation and particulars which may further elucidate and project the Tenderer's experience and competence and details of the system offered.

8.0 DATA TO BE FURNISHED BY SUCCESSFUL TENDERER

8.01 GENERAL

- (i) The Contractor shall furnish a schedule of submission of drawings for approval of Engineer-in-Charge. Submission of drawings shall commence within two weeks after placement of order and shall be complete keeping in view the overall completion schedule of the project.
- (ii) The Contractor shall submit detailed bar chart of all activities pertaining to contract, which will be approved by Engineer-in-Charge and will be subsequently used for review of progress.
- (iii) Detailed billing schedule shall be submitted by Contractor, which will be approved by Engineer-in-Charge and shall be subsequently followed for payment purpose against progress milestones.
- (iv) All drawings, documents, performance curves and manuals for Purchaser's approval /reference and records shall be submitted in six copies.
- (v) After erection of equipment, the Contractor shall submit one soft copy and six sets of all as-built drawings.
- (vi) All drawings shall be fully dimensioned and complete to the extent that may facilitate approval of Engineer-in-Charge in conjunction with other drawings submitted earlier by the Contractor. Cross-references with other drawings and documents shall be clearly indicated.
- (vii) All drawings shall be complete with bill of materials indicating quantity, material specification, unit and total weights and applicable standard code in respect of each item.
- (viii) Shop test certificates, test reports and curves for all items shall be submitted for scrutiny/ approval along with or before inspection call for the item.

8.02 APPROVAL OF DRAWINGS AND DOCUMENTS

- (i) After scrutiny of drawings, the Engineer-in-Charge will return one copy/set of drawings to the Contractor marked with stamp of approval. The stamping shall be in any of the following four categories.
 - 1. Approved.
 - 2. Approved except as noted. Forward final drawing.
 - 3. Comments marked. Resubmission required.
 - 4. Not approved.
- (ii) Drawing under categories 2, 3 and 4 shall be revised to incorporate the comments and resubmitted for final approval. All revisions shall be marked on the drawings, together with date, reference and details of

changes made. Reasons for not incorporating any of the comments made by the Engineer-in-Charge shall be clearly brought out to the attention of the Engineer-in-Charge while submitting the revised drawing.

- (iii) Revised drawing shall be submitted within 15 days from the date of comment on drawing by Engineer-in-Charge.
- (iv) The drawings will be reviewed only for general conformity with contract requirement and specification. The approval will not relieve the Contractor of his responsibility towards adequacy and completeness of design and material and final fitment of parts sub-assemble /assembled at site for satisfactory operation of plant and equipment supplied.

8.03 DATA, DRAWINGS AND DOCUMENTS TO BE SUBMITTED

8.03.2 Immediately after Order Placement

Following drawings/documents with supporting calculations shall be submitted in six copies within two weeks from the date of placement of order for approval/information/ of Engineer-in-Charge.

- (i) List and schedule of submission of drawings
- (ii) Detailed QC and QA plan.
- (iii) Calculations for sizing/selection of equipment.
- (ii) Equipment overall dimension drawing.
- (iii) Layout drawing, foundation plan and load data.
- (iv) GA drawings of civil facilities, buildings, trenches, etc.
- (v) Water and power requirement along with electrical load data.
- (vi) Electrical information.

8.03.3 As per Schedule Agreed with Engineer-in-Charge

Following drawings and documents shall be submitted for approval /reference at a mutually agreed date as per approved overall schedule:

- (i) Detailed specification/data sheets of equipment and auxiliaries.
- (ii) Detailed drawings of all equipment and auxiliaries showing plan, section and elevations.
- (iii) Technical literature / detailed catalogues of all equipment.
- (iv) P & ID and piping layout.
- (v) Electrical and instrumentation drawings.

- (vi) Any revisions in drawings and documents indicated at item no. 7.03.01.
- (vii) Dispatch sequence of all items.
- (viii) Final list of drawings.
- (ix) Final list of special tools & tackles.
- (x) Final list of consumables and spares.
- (xi) As-built drawings as applicable.
- (xii) Test certificates.
- (xiii) Other data/documents as considered necessary for proper up keep and operation of the plant and equipment and as may have been called for in the general conditions of the contract.

8.04 OPERATION AND MAINTENANCE MANUALS

The Contractor shall furnish 3 sets of operation and maintenance instruction manuals meeting the following requirements:

- (i) Instruction manuals shall present the following basic categories of information in practical complete and comprehensive manner prepared for use by operating and /or maintenance personnel.
 - 1. Instruction for initial installation.
 - 2. Instructions for operation, maintenance and repair.
 - 3. Recommended inspection points and periods of inspection.
 - 4. Ordering information for all replaceable parts.
 - 5. Lubrication chart.
- (ii) Information shall be organized in a logical and orderly sequence. A general description of the equipment including significant technical characteristics shall be included to familiarize operating and maintenance personnel with the equipment.
- (iii) Necessary drawings and / or other illustrations shall be included on copies of appropriate certified drawings shall be bound in the manual. Test, adjustment and calibration information, as appropriate, shall be included and shall be identified to specific equipment.
- (iv) A parts list shall be included showing nomenclature, manufacturer's parts number and / or other information necessary for accurate identification and ordering of replaceable parts.

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- (v) Instructions and parts list shall be clearly legible and prepared on good quality paper. Instruction manuals shall be securely bound in durable folders.
- (vi) If a standard manual is furnished covering more than the specific equipment purchased, the applicable model (or other identification) number, parts number and other information for the specific equipment purchased shall be clearly identified.
- (vii) Instruction manuals shall include list of all special tools and tackles furnished with complete drawings and instructions for use of such tools tackles.

SECTION IV ELECTRICAL & ALLIED SERVICES

1.00 GENERAL SPECIFICATIONS

- 1.1 The works shall be executed in accordance with the CPWD General Specifications for Electrical works Part –I Internal (2013), Part III Lifts & Escalators (2003) Part – IV, Substation (2013), Part – V Wet riser & Sprinkler Systems (2006), Part VII DG Sets (2013) and Specifications for Heating, Ventilation & Air Conditioning (2004) with up to date amendments and shall meet the requirements of the Indian Electricity Act rules.
- 1.2 In case of contradictions between the description in schedules of quantities and the Additional Specifications, the former shall prevail.
- 1.3 The work will be executed as per general arrangement drawing and detailed Fabrication drawings duly approved by the Engineer-in –charge. The various items of Equipments will be ordered only after the drawings are approved and quantities in detail of various items are ascertained as per actual requirements. Therefore the actual quantities / measurement may vary from the quantities stipulated in the BOQ.
- 1.4 All the equipment will be duly inspected in the manufacturers' works / premises before dispatch to the site.
- 1.5 The rate is inclusive of all taxes, levies, insurance, freight and nothing additional will be paid as per clauses (commercial conditions) of additional specification of appropriate CPWD specification.
- 1.6 The work will be executed as per the programme of the completion of the project, and as per detailed PERT chart to be approved by the Engineer-in – charge. The delivery & erection Schedule of various materials/equipments will be as per approval of Engineer – in – charge.
- 1.7 **Payment** shall be made as per relevant clause of commercial and additional conditions of CPWD specification of corresponding Electrical works.
- 1.8 **Inspection & Testing:**
HT Panels, Transformers, Busducts, Rising Mains with accessories, MV panels and APFC panels will be inspected in the respective manufacturer's works place before dispatch and routine test as per applicable BIS will be provided for each equipment. Type Test certified of similar rating and specification of transformer shall be submitted. During the testing in the presence of the Engineer-in-Charge

or his authorized representative, the contractor shall ensure compliance with the agreement specifications, conditions and approved drawings.

2.0 UNINTERRUPTED POWER SUPPLY SYSTEM

SCOPE OF WORK:

The scope of work under this head shall include supply, installation testing and commissioning of UPS system.

The electrical loads proposed to be connected to UPSs are, 1. All operation theatres lighting and power loads, 2. All ICU s lighting and power loads and 3. All computers in all the floors. Taken in to account of above mentioned items the total electrical UPS loads have been calculated. As per the UPS loads 2 Nos. of 120 KVA UPS are required to cater supply to all the above defined loads. Provision is also made to connect extra unexpected future small loads to the UPS.

The UPS are proposed to be connected for parallel operation. These UPS are proposed to be erected in the UPS room in the main building. UPS DBs for all the floors for lighting, power and computer plugs are proposed separately and the same are clearly indicated in the schematic diagram and the electrical layout.

2 Nos. of 120 KVA UPSs, battery racks, Panel Boards are all proposed to be erected in the UPS room beneath the ramps in ground floor and the same is shown in the electrical layout drawing.

The load calculation for UPS, the schematic diagram, the electrical layout showing UPS panel boards and DBs are all enclosed separately which are self explanatory and give detailed picture of this proposal.

3.0 SPECIFICATIONS FOR HVAC

1.00 INTRODUCTION

Air conditioning system

It is proposed to provide Central Air-conditioning in certain areas in the Hospital Building. The proposed system will be a Chilled water system incorporating water cooled screw type chillers, cooling towers, water circulation pumps, Air Handling Units (AHUs), Fan Coil Units (FCUs) and other accessories.

1.10 BASIS OF DESIGN

1.11 Location :

Site Location	:	Madurai, Tamil Nadu.
Geographic Location	:	
Latitude & Longitude	:	9°91' N and 77°98'E
Elevation above MSL	:	164.15m

1.12 Outdoor Design Conditions :

Summer

Dry Bulb Temperature	38.5° C
Wet Bulb Temperature	25.6° C

Monsoon

Dry Bulb Temperature	34.5° C
Wet Bulb Temperature	25.6° C

Winter (min.)

Dry Bulb Temperature	20° C
Wet Bulb Temperature	16.7° C

1.13 Inside Design Conditions

All O.T.s and ICUs	22° C ± 1.5° C (69.8° F ± 2.5° F)
Other Areas	24° C ± 1.5° C (75.2° F ± 2.5° F)

1.14 Lighting: 1 W per sq. ft. of floor area, unless otherwise specified.

1.15 Fresh air

For OTs	100 % Fresh Air with HRVs
For Minor OTs	3 air changes per hour
For ICUs	2 air changes per hour

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For other areas 10 CFM per person/ 1 air change per hour,
whichever is greater

1.16 Air filtration

For major OTs HEPA filters

For minor OTs &
ICUs Fine filters of 99% efficiency down to 5 microns
particle size

For other areas: Filters of 90% efficiency down to 20 microns
particle size.

1.17 Areas to be Air conditioned

The various areas that are to be air-conditioned, catered to by AHUs
as well as by FCUs, are indicated in the Tender Drawings.

1.20 SYSTEM DESCRIPTION

For the above cooling requirement a central air conditioning system has been proposed for providing year round thermal environmental control for the various occupied areas. The system selected is a chilled water system incorporating chillers, primary and secondary chilled water pumps, Air Handling Units (AHUs), Fan Coil Units (FCUs) and other accessories.

The system shall consist of Two numbers water-cooled screw type water chilling packages at the selected operating conditions, both of which will be operating at peak load conditions. Provision shall be made in the AC Plant room for installing a third standby Chiller in the future.

There shall be two numbers cooling towers and three numbers condenser water circulation pumps. Out of the three pumps two shall be working and the third will be a standby.

There shall be three primary chilled water pumps and three secondary chilled water pumps, two of each working and the third as standby.

The secondary chilled water pumps will be provided with Variable Frequency Drives (VFDs), operated by pressure sensors in the chilled water pipelines.

The chillers, condenser water pumps and the primary and secondary chilled water pumps shall all be installed in a Plant Room which will be located in the Stilt Floor of the Hospital building. The insulated chilled water header pipes from the AC plant room will be routed by means of masonry shafts to the upper floors of the Hospital building.

The cooling towers will be located in the open terrace of the second floor of the Hospital building.

AHUs fitted with chilled water cooling coils shall be provided for all the large areas and FCUs shall be provided for small areas that are to be air-conditioned.

Chilled water at about 7 degrees Celsius will be circulated from the Chillers by means of the primary and secondary chilled water pumps and insulated chilled water piping through the cooling coils of all the AHUs and FCUs.

The return water from the AHUs and FCUs shall be routed back to the chillers to form a closed loop cooling cycle.

All the AHUs and FCUs will be provided with 2-way flow control valves operated by room thermostats, to regulate the flow of the chilled water through the coils as per the requirement.

The AHUs will be floor-mounted or ceiling suspended types, as per their capacity and overall dimensions.

The major Operation Theaters (OTs) will be provided with 100 % Fresh Air Air-conditioning system. In order to save energy, Heat Recovery Ventilators will be provided for each O.T. These HRVs will be fitted with Heat Recovery Wheels which are capable of efficient heat transfer between the incoming fresh air and the outgoing room air, without mixing of the two air streams. The AHU and the HRV for each O.T. will be installed in the AHU room provided for that O.T.

The FCUs shall be ceiling suspended inside the respective rooms.

In the larger areas, cool dehumidified air from the AHUs shall be uniformly distributed by means of sheet metal ducts and grills.

In the smaller areas, conditioned air from the FCUs shall be blown in to the room by means of a short collar/canvas connection and grills.

Return air shall be routed back to the AHUs/FCUs through the void above the false ceiling.

In all the areas catered to by AHUs, fresh air dampers shall be provided.

In the case of the FCUs, fresh air will be drawn in to the room by means of a short length of pipe installed through an external wall.

All the mechanical equipment such as chillers, pumps, AHUs and FCUs shall be provided with energy efficient motors. All the sensors and controls shall have a high accuracy in order to control the operation accurately and hence minimize the energy consumption of the respective equipments.

The entire system must be designed and installed to achieve the maximum possible energy savings within the specified design parameters.

The chillers must be provided with a Plant Manager Device for hooking up the chillers, pumps and cooling towers. The various controls of the HVAC system like 2-way motorized valves must be BMS compatible.

Under deck thermal insulation shall be provided for the roof of all the conditioned areas exposed to direct sunlight.

SPECIFICATIONS FOR EQUIPMENTS AND SERVICES

2.0 WATER CHILLING PACKAGES

2.1.0 SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of High Efficiency Water cooled Screw type Water Chilling Packages of the specified capacity. They shall be imported units, fully Factory assembled and Tested and ready to be hooked-up and to be operated at site. Each Chilling Package shall comprise the following main components.

2.1.1 SCREW TYPE COMPRESSORS

Each Chilling Package shall have single or multiple screw compressors, to match the specified capacity of the Chilling package. The advantage of multiple compressor chiller is the ease of starting particularly while operating on DG sets.

2.1.2 The screw compressors shall be of mono / twin screw design, and may be of semi sealed/hermetically sealed type. It shall be suitable for operation with R-134a/ R-407c/ R-410a refrigerants.

2.1.3 The screws shall be manufactured from forged steel. The profile of the screws shall permit safe operation up to a speed of 5000 RPM for 50 Hz operation. The compressor shall unload from fully loaded to the minimum capacity by means of hydraulically actuated slide valve, positioned over the screw rotor / pilot operated solenoid valve.

2.1.4 The compressor housing shall be of high grade cast iron, machined with precision, to provide a very close tolerance between the rotor(s) and the housing.

2.1.5 The rotor(s) shall be mounted on anti friction bearings designed to reduce friction and power input. There shall be multiple cylindrical bearings to handle the radial and axial loads.

2.1.6 There shall be built in oil reservoir to ensure full supply of lubricants to all bearings and a check valve to prevent backspin during shut down.

2.1.7 There shall be oil pump or other means of differential pressure inside the compressor for forced lubrication of all parts during startup, running and during shut down. An oil sump header shall be provided in the casing.

2.1.8 The units shall be complete with automatic capacity control mechanism, to permit modulation from 20% to 100% capacity range.

2.2.0 Interlocking

2.2.1 The compressor motor shall be interlocked with the following:-

- i) Differential pressure switch in the chilled water line.
- ii) Differential pressure switch in the condenser water line.
- iii) Anti-freeze thermostat.
- iv) Condenser water pump.
- v) Chilled water pump.

The interlocks shall be provided with indicating lamps or flags in the control panel in the refrigeration plant room.

2.2.2 The compressor drive motors shall be double squirrel cage type and of hermetic / semi hermetic design, and protected against damage by means of built in protection devices.

2.3 CONDENSER .

2.3.1 General

This section deals with shell and tube type water cooled condensers.

2.3.2 Rating

- i) The condenser(s) capacity shall match the compressor(s) capacity specified in the tender specifications. The selection shall be for 4.2 degree C temperature rise of water through the condenser unless otherwise specified in the tender specifications.
- ii) The condenser shall be designed for a fouling factor of 0.0002 hr. sq. m. degree C difference / K. Cal.
- iii) Unless otherwise specified, the condenser shall be designed for a entering water temperature of 32 degree C.

2.3.3 Material and Construction

- i) The condenser shall be horizontal, shell and tube type, designed, constructed and tested for the refrigerant specified in the tender specifications.
- ii) The shell of the condenser shall be made of MS of thickness not less than 8mm, with electric fusion welded seams. The shell capacity shall be such as to hold 1.25 times the refrigerant charge in the machine of which the condenser is a part, under pumped down conditions.
- iii) The end plates of condenser shall be made of MS of thickness not less than 25mm.
- iv) The condenser shall be designed for a working pressure on the refrigerant side suitable for the refrigerant offered, and on the water side for 10 kg./sq. cm. gauge.

- v) The tubes shall be of seamless hard drawn copper and finned, unless otherwise specified. The minimum wall thickness shall be 1.0mm with root thickness of 0.63 mm below the fins.
- vi) Intermediate tube supports of steel shall be provided at not more than 1250 mm intervals to prevent sagging and vibration of the tubes. The condensers shall have water boxes designed for multi pass flow.
- vii) The tubes may be provided with special tabulating arrangement to improve heat transfer where such an arrangement is a standard design of the manufacturer.
- viii) The condensers shall be provided with removable heads on either side made of cast iron or steel with neatly machined surface for effective jointing with the shell for easy accessibility for cleaning / replacement of the tubes. Suitable baffles shall be incorporated to achieve the required number of passes.
- ix) The condenser shall be provided with baffle arrangement for preventing direct impingement of hot gas over the tubes and to enable even distribution of the gas over the tube bundles.
- x) The condenser shall include necessary provision for sub-cooling of the refrigerant where the refrigerating machine is selected with such sub-cooling requirement. The arrangement shall be such that the cold water entering the condenser first cools the liquid refrigerant in the sub-cooler.
- xi) The condenser shall be sand blasted from both inside & outside before assembly.

2.3.4 Connections and Accessories

The condenser shall be provided with the following connections and accessories and conforming to Section 'Refrigerant Piping' where applicable:-

- i) Hot gas inlet and liquid outlet connection. The liquid line connections shall be provided with isolating valves.
- ii) Water inlet and outlet connections
- iii) Pressure relief device
- iv) Drain connection with valve for water side.
- v) Differential flow switch / pressure switch / flow switch / flow sensor in the water line(s).

2.3.5 Pressure Testing

- i) The condenser shall be tested at the works to 1.5 times the maximum working pressure for the refrigerant specified in the tender specifications or 15 kg./sq. cm. , whichever is higher
- ii) The water side of the condenser shall be tested to a hydraulic pressure of 10 kg./sq. cm.

2.4 CHILLER

2.4.1 General

This section deals with shell and tube type Chillers

2.4.2 Rating

- i) The chiller(s) shall match the compressor(s) capacity specified in the tender specifications. The chiller shall be selected for a water temperature drop between 4.5 to 5.5 degree C through the chiller.
- ii) The fouling factor shall be 0.0001 hr. sq. mtr. degree C temperature difference / K. Cal.

2.4.3 Material and Construction

- i) The water chiller shall be horizontal, shell and tube type, designed, constructed and tested for the specified refrigerant
- ii) The chiller shall be designed for a working pressure on the refrigerant side suitable for the refrigerant offered, and on the water side for 10 kg./sq. cm. gauge.
- iii) The end plates of chiller shall be made of MS of thickness not less than 25mm.
- iv) The shell of the chiller shall be made of MS of thickness not less than 8mm with electric fusion welded seams.
- v) The tubes shall be of seamless, hard drawn copper with a minimum tube wall thickness of 0.71 mm for plain tubes & minimum 0.63mm at the root of fins for finned tubes.
- vi) The tubes shall be plain for DX type chillers.
- vii) The tubes shall be rolled into grooves in the tubes sheets and flared at ends.
- viii) The DX type chillers shall be provided with adequate number of properly spaced baffles to ensure the highest heat transfer efficiency between the water and the refrigerant.
- ix) The chiller shall be smooth finished with one coat of zinc chromate primer before the insulation is applied.
- ix) The chiller shall be sand blasted from both inside (before insertion of tubes) & outside.
- x) The chiller shall be ARI certified and COP shall be not less than 5.8 at ARI conditions.

2.4.4 Connections and Accessories

The chiller shall be provided with the following connections and accessories and conforming to the Section 'Refrigerant Piping' where applicable:-

- i) Refrigerant inlet and outlet connections
- ii) Thermostatic/electronic expansion valve(s) with adjustable superheat control and external equalizer.
- iii) Line solenoid valve, or pilot solenoid valves as required
- iv) Water inlet and water outlet connections
- v) Drain connection with stop valve for water side only
- vi) Vent connection with valve
- vii) Flow switch in water line

2.4.5 Pressure Testing

- i) The chiller shall be tested in the works to 1.5 times the maximum working pressure for the refrigerant specified in the tender specifications, or 21 kg./sq. cm. (Pneumatic), whichever is higher.
- ii) The water side of the chiller shall also be tested to a hydraulic pressure of 10 kg./sq. cm.

2.5 REFRIGERANT PIPING

2.5.1 General

This section deals with the refrigerant piping of the chilling package.

2.5.2 Design aspects of Refrigerant Piping

- i) Refrigerant piping shall be designed and installed so as to:
 - a) Ensure circulation of adequate refrigerant at all loads.
 - b) Ensure oil return to crank case of compressor positively and continuously.
 - c) Keep pressure losses within limits, especially in suction lines.
 - d) Prevent liquid refrigerant from entering the compressor when the compressor is working as well as when it has stopped.
 - e) Prevent trapping of oil in evaporator or suction lines, which may return to the compressor in the form of slugs.
- ii) Hot gas lines:
 - a) Oil shall be entrained and carried by hot gas under all load conditions likely to be encountered in normal operation.
- iii) Liquid Lines:

- a) Liquid lines shall be designed to ensure that flashing of liquid refrigerant does not occur by minimizing the pressure drop suitably and by appropriate sub cooling.
- b) Each liquid line shall be provided with a permanently installed refrigerant drier of throw away or rechargeable type. The drier shall be installed in a valved line.
- c) Flow indicator (moisture indicating type) shall be installed on all liquid lines.
- iv) Suction Lines:
 - a) Oil shall be entrained and carried by the suction gas under all conditions of load likely to be encountered in normal operation.
 - b) Piping shall be designed for a suitable velocity of refrigerant (similar to hot gas line) to ensure that oil will not separate from the gas and drain to the compressor in slugs.
 - c) The refrigeration system shall be equipped with controls for pump down system so that the evaporator and suction line are emptied before the compressor shuts off, thus preventing liquid refrigerant from entering the compressor when restarted.
 - d) Refrigerant lines shall be sized to limit pressure drop between evaporator and condensing unit to less than 0.2 kg. per sq. cm. (3 psi).
- v) Isolating valve shall be provided to enable isolation of each compressor in case of multiple compressor units (as built in valves), strainer, drier and any other components as may be required for proper operation and maintenance.
- vi) Thermostatic/electronic expansion valve shall be provided in the refrigerant circuit.

2.5.3 Material

- i) Refrigerant piping shall be of copper to manufacturer's standards.
- ii) Valves shall be of the packed, back-seating type and these shall be of forged brass construction.

2.5.4 Pressure Testing

- i) After completion of the piping installation at the factory, the entire chilling unit shall be pressure tested with dry nitrogen or any other inert gas at the following pressures for the particular refrigerant to be used:-

Refrigerant	Test pressure (Kg./Sq. cm. (Gauge))
-------------	-------------------------------------

	High pressure side	Low pressure side
R - 134a	20	8

This test shall be carried out as follows:

- a) The system shall be charged with nitrogen or inert gas to 1.0 Kg./sq. cm. gauge and all joints shall be checked for leakage with a mixture of four parts water, one part liquid soap and a small amount of glycerin. Leaks shall be marked, pressure released and repairs done. Brazed joints, which leak, shall be opened and redone. These shall not be repaired by addition of brazing alloy to the joints.
 - b) The system shall now be charged with nitrogen or the inert gas to the pressure specified in the above table and the process of locating leaks and repairs shall be repeated.
- iii) Final pressure test:

After all the leaks have been repaired, the system shall be retested with the test pressure maintained for a period of not less than 8 hours. No measurable drop in pressure should be detected after the pressure readings are adjusted for temperature changes.

Pressure gauges, controls and compressors may be valved off during pressure testing.

2.6 MICROPROCESSOR CONTROLLER

2.6.1 General

This section deals with the microprocessor controls of the chilling package.

2.6.2 Each chilling unit shall be complete with a microprocessor based interactive control console in a locked enclosure, factory mounted, directly on the unit, pre-wired with all operating and safety controls and tested.

2.6.3 It will provide start, stop, safety, interlock, capacity control and indications for operation of the chiller unit through an alphanumeric / graphical display.

2.6.4 Controls shall provide to view and change digital programmable essential set points, cause of shutdown and type of restart required.

- a) Leaving chilled water temperature,
- b) Percent current limit.
- c) Remote reset temperature range.

2.6.5 All safety and cycling shutdowns shall be enunciated through the alphanumeric / graphical display and consist of day, time, cause of shutdown and type of restart required.

- 2.6.6 Cycling shutdown shall include low leaving chilled water temperature, chiller / condenser water flow interruption, power fault, internal time clock and anti-recycle.
- 2.6.7 Safety shutdowns shall include low oil pressure, high compressor discharge temperature, low evaporator pressure, motor controller fault and sensor malfunction.
- 2.6.8 The display screen shall indicate the following minimum information
- i) date and time
 - ii) supply and return chilled water temperatures
 - iii) supply and return condenser water temperatures
 - iv) differential oil pressure
 - v) percent motor rated current
 - vi) evaporator & condenser refrigerant saturation temperatures
 - vii) chiller operating hours and number of compressor starts
 - viii) oil sump temperature
 - ix) status message
- 2.6.9 Security access shall be provided to prevent unauthorized change of set points, to allow local or remote control of the chiller and to allow manual operation of the pre rotation vanes and oil pump.
- 2.6.10 The chiller shall be provided with ports compatible with any building management system offered, to output all system operating information, shutdown/ cycling message and a record of last four cycling or safety shutdowns to a remote printer (option). The control centre shall be programmable to provide data logs to the printer at a set time interval.
- 2.6.11 Control centre shall be able to interface with an automatic controls system to provide remote chiller start / stop; reset of chilled water temperature, reset of current limit, and status messages indicating chiller is ready to start, chiller is operating, chiller is shut down on a safety requiring reset and chiller is shut down on a recycling safety.
- 2.6.12 The microprocessor control system shall include the interlocking of compressor motor with chilled and condenser water flows and lubricating oil pump pressure.
- 2.6.13 At the time of START, the microprocessor control system shall check all pre-start safeties to verify that all restart safeties are within limits. If any one is not within limits, an indication of the fault will be displayed and the start aborted.

2.7 INSTALLATION

2.7.1 General

This section deals with the installation of the chilling package.

The complete chilling unit shall be installed over a RCC foundation and shall be adequately isolated against transmission of vibrations to the building structure.

Necessary foundation bolts, nuts, leveling screws etc wherever required for mounting the unit shall be provided by the contractor.

2.8 PAINTING

The equipment shall be supplied as per manufacturer's standard finish painting on zinc chromate primer.

2.9 FACTORY INSPECTION

The assembled chilling packages will be inspected, if the need be, by the Users / Consultants before they are dispatched to the site. The Bidders may indicate the cost involved for this factory visit and testing by the Users / Consultants in their scope.

3.0 COOLING TOWERS

3.1 SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of mechanical draft type Cooling towers.

3.2 DESIGN

- i) Rating:
The cooling tower shall be rated for the heat rejection capacity specified in the tender specifications.
- ii) Range:
The Cooling tower shall be designed to cool the requisite quantity of water through 4.2 degree C or as specified in the tender specifications, 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 4.0 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).

3.3 MATERIAL AND CONSTRUCTION

Fiberglass Reinforced Plastic (FRP) Cooling tower:

- i) 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.

- ii) The cooling tower shall be induced draft type, with FRP casing in square/rectangular shape and with a FRP basin to match the shape of the casing. Rotating type sprinklers will not be accepted.
- iii) The air intake shall be from openings all along the sides of the casing near its base. These openings shall be covered with hot dip galvanized expanded metal mesh screens.
- iv) The basin shall have a holding capacity adequate for operation for at least 30 minutes without addition of make-up water to the basin. The construction should be such as to eliminate the danger of drawing air into the pump when operating with minimum water in the basin.
- v) The basin fittings shall include the following:
 - a. Bottom / side outlet.
 - b. Drain connection with valve.
 - c. Float valve type automatic make-up connection with valve.
 - d. Overflow connection.
 - e. Bleed off with valve, from inlet header to overflow pipe.
- vi) 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.
- viii) 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.
- ix) 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.
- x) 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.
- xi) The fan shall be multi-blade axial flow type, made of Aluminium alloy or FRP. The fan assembly shall be statically and dynamically balanced.
- xii) The fan drive shall be direct from a three phase induction motor. The entire drive arrangement shall be designed for a minimum noise and it shall be rigidly supported to the tower structure.
- xiii) To ensure safety of personnel at the time of working on cooling tower a steel ladder shall be provided in such a manner and location as necessary to give safe and complete access to all the parts of the cooling

tower requiring inspection or adjustments. The ladder shall be bolted to the tower at the top and grouted in masonry at the bottom end.

- xiv) 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.

3.4 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.

3.5 PAINTING

The cooling towers shall be supplied with the manufacturer's standard finish painting with zinc chromate primer.

4.0 WATER CIRCULATING PUMPS

4.1 SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of water circulation pumps. The pumps shall be centrifugal type direct driven with a 3 phase, $415 \pm 10\%$ volts, 50HZ, AC motor. The pumps may be of back pull out type with operating speed not exceeding 3000rpm. These pumps are to be used for circulating condenser water, primary chilled water and secondary chilled water in the respective circuits.

4.2 RATING

The pumps shall be suitable for continuous operation in the system. The head and discharge requirements shall be as specified in the tender documents for the respective circuits. The discharge rating shall not be less than the flow rate requirement of the respective equipments through which the water is to be pumped. The head shall be suitable for the system and shall take into consideration the pressure drops across the various equipments and components in the water circuit as well as the frictional losses. The pumps offered shall be of high efficiency.

4.3 MATERIAL AND CONSTRUCTION

- i) The centrifugal pumps shall conform to IS 1620 standard. The motor shall be totally enclosed fan cooled type.
- ii) The pump casing shall be of heavy section close grained cast iron. The casing shall be provided with air release cock, drain plug and shaft seal

arrangement as well as flanges for suction and delivery pipe connections as required.

- iii) The impeller shall be of bronze or gunmetal. This shall be shrouded type with machined collars. Wear rings, where fitted to the impeller, shall be of the same materials as the impeller, The impeller surface shall be smooth finished for minimum frictional loss. The impeller shall be secured to the shaft by a key.
- iv) The shaft shall be of stainless steel and shall be accurately machined. The shaft shall be balanced to avoid vibrations at any speed within the operating range of the pump.
- v) The shaft sleeve shall be of bronze or gunmetal. This shall extend over the full length of the stuffing box or seal housing. The sleeve shall be machined all over and ground on the outside.
- vi) The bearings shall be ball or roller type suitable for the duty involved. These shall be grease lubricated and shall be provided with grease nipples/cups. The bearings shall be effectively sealed against leakage of lubricant.
- vii) Mechanical shaft seals having carbon or other suitable hard wearing surface and stainless steel compression springs shall be provided. A drip well with drain piping shall be provided beneath the seal.
- xv) The pumps, shall be directly coupled to the motor shaft through, a flexible coupling protected by a coupling guard.
- ix) The pump and motor shall be mounted on common base plate either of cast iron or fabricated from rolled steel section. The base plate shall have rigid, flat and true surfaces to receive the pump and motor mounting feet.

4.4 ACCESSORIES

Each pump shall be provided with the following accessories:

- i) Butterfly valves on suction and discharge sides
- ii) Reducers, if required to match the sizes of the connected pipe work.
- iii) Non return valve on the discharge side.
- iv) 'Y' type strainer on the water inlet side.

4.5 INSULATION

The thermal insulation of the pump casing for chilled water circulating pumps shall be of the same type and thickness as provided for the connected pipe work.

4.6 INSTALLATION

- i) The pump and motor assembly shall be mounted and arranged for ease of maintenance and to prevent transmission of vibration and noise to the building structure or excess vibration to the pipe work.
- ii) The pump and motor assembly shall be installed on a cement concrete block. The mass of the inertia block shall not be less than the combined mass of the pump and motor assembly. The inertia block shall be vibration isolated from the plant room floor by 25 mm thick neoprene rubber pads or any other equivalent vibration isolation fittings. The pump motor sets shall be properly aligned to the satisfaction of the engineer-in-charge.

4.7 PAINTING

The pumps shall be supplied with the manufacturer's standard finish painting with zinc chromate primer.

5.0 VARIABLE SPEED PUMPING SYSTEM

The Variable Speed Pumping system are to be provided for the Secondary Chilled water pumps. This system shall consist of the Variable Frequency Drive, Pressure sensor transmitter, Pump Control Panel and power and control wiring and shall be provided all the secondary chilled water pumps.

5.1 VARIABLE FREQUENCY DRIVE

- i) The Variable frequency drives shall be Pulse Width Modulation (PWM) type, microprocessor controlled design.
- ii) The Variable Frequency Drive (VFD), including all factory installed options, shall be tested to UL standard 508. The VFD shall also meet C-UL and be CE marked and built to ISO 9001 standards.
- iii) The VFD shall be housed in a NEMA 1 enclosure.
- iv) The VFD shall employ an advanced sine wave approximation and voltage vector control to allow operation at rated motor shaft output speed with no de-rating. 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.
- v) The VFD shall have balanced DC link reactors to minimize power line harmonics.
- vi) Input and output power circuit switching shall be done without interlocks or damage to the VFD.
- vii) The following User friendly adjustments shall be provided:
 - a) Accel time
 - b) Decel time
 - c) Minimum Frequency
 - d) Maximum Frequency

- viii) 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.
- ix) The VFD shall be capable of displaying the following information in alphanumeric display:
 - a) Frequency
 - b) Voltage
 - c) Current
 - d) Kilowatts per hour
 - e) Fault Identification
 - f) Percent Torque
 - g) Percent Power
 - h) RPM

5.2 AUTOMATIC VFD BYPASS

- a) Variable speed pumping system shall be equipped with an automatic bypass.
- b) Bypass shall consist of a main power disconnect with ground fault protection, a pair of interlocked contactors and a motor overload relay. All are to be mounted in a NEMA 1 enclosure.

5.3 SENSOR / TRANSMITTERS

- a) Differential pressure sensor transmitters are to be supplied and installed at the outlet of each secondary chilled water pump. These sensors shall transmit an isolated 4-20mA DC signal indicative of process variable to the pump logic controller via standard two wire 24V DC system. It shall have a NEMA 1 electrical enclosure capable of withstanding 150 PSI static pressure. Accuracy shall be within 0.5% of full span.

5.4 PUMP LOGIC CONTROLLER

- i) The controller shall meet Part 15 of FCC regulations pertaining to class A computing devices. The controller shall be specifically designed for variable speed pumping applications.
- ii) The controller shall function to a proven program that safeguards against hydraulic conditions including:
 - a) Pump flow surges
 - b) Hunting
 - c) End of curve
 - d) System over pressure

- e) NPSHR above NPSHA
- f) Motor overload
- iii) The pump logic controller shall be capable of receiving up to two discrete analog inputs from zone sensor / transmitter. It will then select the analog signal that has deviated the greatest amount from its set point. 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 up to four pumps in parallel.
- iv) 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.
- v) 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.
- vi) The operator interface shall have the following features:
 - a) Multi-fault memory and recall last 10 faults and related operational data
 - b) Red fault light, Yellow warning light and Green power on light.
 - c) Soft-touch membrane keypad switches.
- vii) 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.
- viii) Controller shall be capable of performing the following pressure booster function:
 - a) Low suction pressure cut-out to protect the pumps against operating with insufficient suction pressure.
 - b) High system pressure cut-out to protect the piping system against high pressure conditions.
 - c) No flow shut down to turn the pumps off automatically when there is no flow.
- ix) The following communication features shall be provided to the BMS :
 - a) Remote system start / stop non-powered digital input.
 - b) Failure of any system component. Output closes to indicate alarm condition.
 - c) One 4-20 mA output with selectable output of :
 - Frequency
 - Process Variable
 - Output Current
 - Output power.

- x) 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.
 - a) Individual Analog Input
 - b) Individual Zone Set Points.
 - c) Individual Pump / AFD on/off status.
 - d) System percent speed.
 - e) System Start / Stop command
 - f) System operation mode.
 - g) Individual KW signals.
 - h) System flow, when optional flow sensor is provided.

5.5 THE COMPLETE VFD SYSTEM

- a. The pump and the VFD must be compatible.
- b. 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.
- c. The system shall include the programmable logic pump controller, variable frequency drive(s) and remote sensor / transmitters as indicated.
- d. The variable speed pump logic controller, adjustable frequency drives, AFD bypass and pressure sensor / transmitters shall be supplied as individual components and assembled at the job site.
- e. Power and control wiring for this system shall be supplied and installed by the Air-conditioning contractor to ensure a single point responsibility for the performance of the system. Power source with the necessary Switches will be provided by the Owners in the Motor Control Centre in the AC Plant room.

6.0 AIR HANDLING UNIT (AHU)

6.1 SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of Chilled water Air handling Units. The air handling units shall be of double skin construction, draw through type in sectionalized construction consisting of blower section, coil section, filter section and insulated drain pan. Unless otherwise specified, the unit shall be horizontal type.

6.2 Rating

- i) The capacity of the cooling coil, the air quantity from the blower and static pressure of blower fan shall be as laid down in the tender documents.
- ii) The coil shall be designed for a face velocity of air not exceeding 165 m/min.

- iii) The requisite static pressure demanded by the air circuit shall be developed by the fan at the selected operating speed. The static pressure value shall not in any case be less than 40mm water gauge in normal cases, not less than 65mm water gauge where 5 micron particle size filters are used and not less than 100 mm where 0.3 micron particle size filters are used.. The fan motor HP shall be suitable to satisfy these requirements and the drive losses.
- iv) Maximum fan speed
 - a) Fans up to and including 300 mm dia : 1440 RPM
 - b) Fans above 300 mm dia : 900 RPM
- v) The air outlet velocity from the centrifugal blower shall not exceed 650m/min.
- vi) Maximum fan motor speed : 1440 RPM
- viii) Noise level at a distance of 1M from AHU shall not exceed 75 dBA.

6.3 Housing / Casing

- i) The housing/ casing of the air handling unit shall be of double skin construction. The housing shall be so made that it can be delivered at site in total / semi knocked down condition, depending upon the requirements. The main framework shall be extruded aluminium hollow structural sections. All the framework shall be assembled using mechanical joints to make a sturdy and strong framework for various sections. For 100% fresh air application framework shall be made of thermal break hollow extruded aluminium profile.
- ii) Double skin panels shall be 25mm thick, made of 0.8mm thick GSS with powder coated finish on the outside and 0.8mm thick GSS inside, with Polyurethane foam insulation of density not less than 38 kg/cum injected in between by injection moulding machine. These panels shall be bolted from inside/screwed from outside on to the framework with soft rubber gasket in between to make the joints airtight. The gaskets shall be inserted within grooves in the extruded aluminium profile of the framework. For units installed outdoors, the thickness of double skin panels shall be minimum 40mm.
- iii) Frame work for each section shall also be bolted together with soft rubber gasket in between to make the joints airtight. Suitable doors with nylon handles, aluminium die-cast powder coated hinges & latches shall be provided for access to various panels for maintenance. However, AHU in the form of complete single unit shall also be acceptable with access door(s) for maintenance to various sections. The entire housing shall be mounted on galvanized steel channel frame work made out of GI sheet of thickness not less than 2mm. For higher capacity AHUs hot dip galvanized steel channel frame work made of minimum 3mm thick GS sheet shall be used.

6.4 Drain pan

Drain pan shall be made out of minimum 1.25mm thick stainless steel sheet externally insulated with 10mm thick closed cell Polyethylene foam insulation with necessary dual slope to facilitate fast removal of condensate. Necessary supports will be provided to slide the coil in the drain pan.

6.5 Cooling coil

- i) The coil shall be made from seamless solid drawn copper tubes. The minimum thickness of tube shall be 0.5mm and diameter 12.5 mm.
- ii) The depth of the coil shall be such as to suit the requirements, viz. re-circulated air application or 100% fresh air application. The coil shall be 4 or 6 rows deep for normal re-circulated air application and 8 rows deep for all outdoor air application, unless otherwise specified.
- iii) U bends shall be of copper, jointed to the tubes by brazing, soft soldering shall not be used.
- iv) Each section of the coil shall be fitted with flow and return headers to feed all the passes of the coil properly. The headers shall be complete with water in/out connections, vent plug on top and drain at the bottom. The coil shall be designed to provide water velocity between 0.6 to 1.8 m/s in the tubes.
- v) The fins shall be of aluminium. The minimum thickness of the fins shall be 0.15mm. The number of fins shall not be less than 5 per cm length of coil. Fins shall be of plate type. The tubes shall be mechanically expanded to ensure proper thermal contact between fins and tubes. The fins shall be evenly spaced and upright. The fins bent during installation shall be carefully realigned. For coastal areas fins shall be phenolic coated. For 100% F.A. application fins shall be hydrophilic type.
- vi) The coil shall be suitable for chilled water and shall be designed for a working pressure of 10 kg/sq. cm.
- vii) Shut off and regulating valves shall be provided at the water inlet and outlet.

6.6 Supply Air Fan and Drive

- i) The supply air fan shall be AMCA certified centrifugal type with forward / backward curved blades double width type. For static pressure up-to 65mm forward curved blades shall be used and for higher static pressures backward curved blades shall be used.
- ii) The fan housing shall be of Galvanized sheet steel and the impellers shall be fabricated from heavy gauge steel sheet as per approved manufacturers standard. The side plates shall be die formed for efficient, smooth airflow and minimum losses. Fan impeller shall be mounted on solid shaft

supported to housing using heavy duty ball bearings. Fan housing and motor shall be mounted on a common base frame mounted inside the fan section on anti-vibration spring mounts or cushy-foot mount. The fan outlet shall be connected to casing with the help of fire retardant fabric.

- iii) The fan impeller assembly shall be statically and dynamically balanced.
- iv) The fan shall be fitted with vee belt drive arrangement consisting of not less than two evenly matched belts. Belts shall be of oil resistant type. Adequate adjustments shall be provided to facilitate belt installation and subsequent belt tensioning by movement of the motor on the slide rails. A readily removable guard shall be provided.
- v) The fan motor shall be totally enclosed fan cooled squirrel cage induction motor with IP-54 protection and selected for quiet running. The motor shall be suitable for operation on $415 \pm 10\%V$, 3 PHASE, 50 Hz., AC supply. The motor shall conform to IS:325 - 'Three phase induction motors' having class F insulation.

6.7 Air Filters

- i) Metallic viscous type filter made out of aluminium wire mesh or of dry cleanable synthetic fabric type, minimum 50mm thick, shall be provided on the air suction side of the AHU as standard equipment with the unit.

These filters shall have an efficiency of 90% down to 20 microns particle size. Face velocity across these filters shall not exceed 155 m/min.

- ii) Each AHU shall be provided with a filter section containing pre-filters made of cleanable metal viscous filters made of corrugated aluminium wire mesh, or dry cleanable synthetic fabric filters. These shall be minimum 50mm thick with a frame work of aluminium.
- iii) The filter area shall be made up of panels of size convenient for handling. The filter panels shall be held snugly within suitable aluminium framework made out of minimum 1.6mm aluminium sheet with sponge neoprene gaskets by sliding the panels between the sliding channels so as to avoid air leakage.

- iv) Fine Filters

Special filters having an efficiency of 99% down to 5 microns particle size shall be provided in the AHUs that will be catering to the critical areas like ICUs, OTs etc. The list of these areas is indicated in Basis of Design 1.06 and also in the Schedule of Quantities. The filters shall be of special media fixed in sheet metal housing made of aluminium sheet and bonded with suitable agents to obtain leak proof joints. The AHUs shall be designed with suitable space for the installation of these filters. Sheet metal framework of aluminium shall be provided for the installation of the filters. Neoprene rubber gaskets shall be used to ensure leak proof installation. Adequately

sized inspection doors shall be provided easy access to the filters. This is of importance since some of the AHUs will be ceiling suspended.

6.8 Instruments and Valves

The following instruments shall be provided at the specified locations in the AHUs.

- i) Pressure gauges at the inlet and outlet of the coil with MS couplings welded to the pipe, siphon and gauge cock.
- ii) Stem type thermometers at the inlet & outlet of coil with MS couplings welded on to the chilled water pipeline.
- iii) Butterfly valve at the inlet and outlet of coil.
- iv) Balancing valve at the outlet of coil.
- v) Y-strainer at the inlet of coil.
- v) Motorized 2-way modulating valve along with proportionate thermostat.

6.9 Installation

The air handling unit shall be so installed as to transmit minimum amount of vibration to the building structure. Adequate vibration isolation shall be provided by use of rubber / neoprene pads.

6.10 Testing

Cooling capacity of the various air handling units shall be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Flow measurements shall be by an anemometer and temperature measurements by accurately calibrated mercury-in-glass thermometers. Computed results shall conform to the specified capacities and quoted ratings.

7.0 HEAT RECOVERY VENTILATOR

7.1 SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of Heat Recovery Ventilator (HRV).

7.2 The HRV casing shall be of double skin construction similar to the AHUs specified in 6.0. The casing shall be fabricated out of powder coated sheet metal sections with 25 mm thick poly urethane foam (PUF) insulation sandwiched in-between.

7.3 Two centrifugal blowers shall be provided inside the casing, along with their drive motors and belt drive arrangements. The two blowers shall both be of the

same capacity. The specifications of the blowers and motors shall be similar to that indicated in 6.0.

- 7.4 The casing shall be partitioned horizontally to form two separate air flow systems. One will be for exhausting the room air to the outside and the other shall be for supplying fresh air into the room from the outside.
 - 7.5 A Heat Recovery Wheel shall be provided in the centre of the casing. This HRW shall be of adequate surface area and provided with a chemical coating to facilitate a minimum of 85% heat transfer, both Sensible and Latent Heat, between the two opposing air streams.
 - 7.6 Suitable flanges shall be provided in the casing for duct connections for fresh air inlet and outlet and exhaust air inlet and outlet. Flexible canvas connections shall be provided at these four connections. Suitable inspection doors shall be provided in the casing for access to the internal parts for maintenance and inspection.
 - 7.7 The air flow capacities for the fresh air and the exhaust air shall be as indicated in the Schedule of Quantities.
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7.8 The Heat Recovery 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 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, sectorized, 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 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 as per manufacturer standard. A computerized selection should be enclosed along with offer.

- b. Casing : The casing shall be constructed as a 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 limits 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.

8.0 HEPA Filter Modules

8.1 SCOPE

The scope of this section is the supply, installation, testing and commissioning of HEPA Filter Modules.

The major Operation Theaters shall be provided with HEPA filter modules. The HEPA filters shall be of special media having an efficiency of 99.97% down to 0.3 microns particle size. The filters shall be housed in an aluminium casing which shall be installed in an inverted Tee grid which shall be suspended from the ceiling inside the Operation Theater. The HEPA filter modules shall be installed vertically above the operating table in order to achieve a sterile zone in the operating area. The filter module shall be provided with a round connection piece doe connecting the flexible aluminum duct from the main supply air duct from the AHU. The rating of the filter module shall be as indicated in the Schedule of Quantities.

9.0 FAN COIL UNITS (FCU)

9.1 SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of fan coil units. The Fan Coil Units shall be ceiling suspended blow through type complete with finned chilled water coil, centrifugal blowers and drive motor, insulated drain pan, cleanable air filters and fan speed regulator and other controls as described.

9.2 Casing

The casing shall be fabricated out of GSS sheet having a minimum thickness of 1.25mm.

9.3 Cooling coil

The coil shall be of seamless copper tubes with aluminium fins. The fins shall be uniformly bonded to the tubes by mechanical expansion of the tubes. The

coil circuit should be sized for adequate water velocity but not exceeding 1.8 m/s. The air velocity across the coil face shall not exceed 165 m/min.

9.4 Fan

This shall consist of two light weight aluminium impellers of forward curved type, both statically and dynamically balanced, along with properly designed GI sheet casings.

The two impellers shall be directly mounted on to a double extension shaft, single phase multiple winding motor capable of running at three speeds.

9.5 Drain pan

Drain pan shall be fabricated out of minimum 1.00 mm thick stainless steel sheet covering the whole of the coil section and extended on one side for accommodating coil connections, valves etc. and complete with a 25mm drain connection. The drain pan shall be insulated with 10mm thick closed cell polyethylene foam insulation.

9.6 Air filter

The filter shall be cleanable type 15mm thick with 90% efficiency down to 20micron and to be mounted on the air inlet side.

9.7 Speed control

A sturdy switch shall be provided with the unit complete with wiring, for ON/OFF operation and with minimum three speed control of the fan.

9.8 Automatic controls

Each unit shall have a room thermostat and a 2-way motorized valve. The valve shall be fixed on the water outlet side of the Unit. The thermostat and the three speed fan switch shall be a combination control unit having a aesthetic appearance.

The water valves on inlet line shall be of gun metal ball type with internal water strainers. The valves on return line shall be without the water strainer.

9.9 Water connections

The water lines shall be connected to the cooling coil of the fan coil unit, by at least 300mm long, type 'L' seamless solid drawn copper tubing, with flare fittings and connections.

9.10 Painting

All the sheet metal components of the Fan Coil Unit shall be given a powder coat finish.

10.0 VENTILATING FANS

10.1 Propeller fans

The scope of this section is the supply, installation, testing and commissioning of Wall mounted propeller fans.

In the case of individual toilets the exhaust fans shall be mounted directly in an external wall of the toilet. In the case of toilets with multiple cubicles a ducted exhaust system shall be provided to properly exhaust the air from all the cubicles. In this case the exhaust fan shall be installed in an external wall of the toilet, above the level of the false ceiling that will be provided. Short lengths of GI sheet metal ducts and exhaust grills shall be provided for connection to the exhaust fan. The fans shall be of the Axial flow type of robust design, suitable for continuous duty in industrial applications. The fans shall be complete with mounting frame, cowl and mesh.

The ratings are indicated in the Bill of Quantities.

10.2 Centrifugal fans

The scope of this section is the supply, installation, testing and commissioning of Centrifugal fans for exhaust systems for CSSD, Laundry and the Hospital Kitchen.

These Centrifugal exhaust fans shall be of Single Inlet Single Width (SISW) construction, fitted with drive motors of the required capacity. The drive arrangement shall be direct or belt driven.

SHEET METAL DUCTING

11.1 SCOPE

The scope of this section is the supply, installation, testing and commissioning of sheet metal air ducts.

- i) Ducts shall be factory fabricated and shall be generally as per IS: 655 'Specifications for metal air ducts', unless otherwise specified.
- ii) No variation of duct configuration or sizes is permitted except with written permission. Size of the round ducts installed in place of rectangular ducts or vice versa shall be in accordance with ASHRAE table of equivalent rectangular and round ducts.
- iii) Circular ducts, where provided shall be of thickness as specified in IS: 655 and its latest amendments.
- iv) All circular ducts and fittings shall be factory fabricated and shall be as shown on the contract drawings.
- v) Duct design:

Maximum flow velocity	:	1500 Ft/Min.
Maximum friction	:	0.1 in.WG/100 Ft. Run

N.B. Whichever of the above two values is lower, shall be selected.

Maximum velocity at supply air outlet	:	400 Ft/Min.
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Noise Level Design Criteria

In accordance with Design Standards and Criteria, permissible noise level in various spaces, considered when unoccupied, shall be as follows:

S.No.	Area	Acceptable Noise Levels (NC)
a.	Private Rooms	25 - 30
b.	OT	35 - 40
c.	Corridors	35 - 40
d.	Wards	30 - 40
e.	Public Areas	35 - 40

11.2 DUCT MATERIAL

- i) The thickness of sheets for fabrication of rectangular ductwork shall be as under. The thickness required corresponding to the longest side of the rectangular section shall be applicable for all the four sides of the ductwork.

Longest side (mm)	Minimum sheet thickness
	(mm)
750 mm and below	0.63
751 mm to 1500 mm	0.80
1501 mm to 2250 mm	1.00
2251 mm & above	1.25

FOR ALUMINUM DUCTS MATERIAL SHALL BE ONE COMMERCIAL GAUGE HIGHER WITH 22 G AS MINIMUM

- ii) Flanges for duct joints, stiffening angles (braces) and supporting angles shall be of rolled steel sections, and of the following sizes.

Application	Duct Width	Angle size
Flanges	Upto 1000 mm	35mm x 35mm x 3mm
-do-	1001mm to 2250 mm	40mm x 40mm x 3mm
-do-	More than 2250 mm	50mm x 50mm x 3mm
Bracings	Upto 1000 mm	25mm x 25mm x 3mm
-do-	More than 1000 mm	40mm x 40mm x 3mm
Support angles	Upto 1000 mm	40mm x 40mm x 3mm
-do-	1001mm to 2250 mm	40mm x 40mm x 3mm

-do-	More than 2250 mm	Size and type of RS section shall be decided in individual cases
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- iii) All spiral ducts and fittings shall be manufactured from GS Sheets conforming to the standards ASTMA924 and ASTM A653 - galvanized steel sheet, lock-forming quality, having the required zinc coating in conformance with ASTM A90.
- iv) Hangers shall be fully threaded rods of 8mm dia. Galvanized mild steel for duct sizes up to 1500 mm and of 10mm dia for ducts upto 2250mm size, and 12 mm dia for larger sizes.
- v) All nuts, bolts and washers shall be zinc plated steel. All rivets shall be galvanized or shall be made of magnesium - aluminium alloy. Self tapping screws shall not be used.
- vi) Hanger Straps: ASTM A653 galvanized steel with zinc coating as per ASTM A90.
- vii) Structural Steel Members: ASTM A36 steel.

11.3 DUCTWORK FABRICATION

- viii) The interior surfaces of the ducting shall be smooth.
- ix) All the ducts up to 600 mm longest side shall be cross broken between flanges by a single continuous breaking. Ducts of size 600 mm and above shall be cross broken by single continuous breaking between flanges and bracings. Alternatively, beading at 300mm centres for ducts up to 600 mm longest side, and 100 mm centres for ducts above 600 mm size shall be provided for stiffening.
- iii) All sheet metal connections, partitions and plenums required for flow of air through the filters, fans etc. shall be at least 1.25 mm thick galvanized steel sheets and shall be stiffened with 25 mm x 25 mm x 3 mm angle iron braces.
- iv) As far as possible, long radius elbows and gradual changes in shape shall be used to maintain uniform velocity accompanied by decreased turbulence, lower resistance and minimum noise. The ratio of the size of the duct to the radius of the elbow shall be normally not less than 1:1.5.
- v) Flanged joints shall be used at intervals not exceeding 2500 mm. Steel flanges shall be welded at corners first and then riveted to the duct.
- vi) Plenums for filters shall be complete with suitable access door of size 450 mm x 450 mm.

- vii) Provide rectangular 45 degree entry fittings for rectangular ducts and 45 degree wye takeoffs for round ducts.
- viii) Duct sizes indicated are inside clear dimensions.
- viii) Increase duct size gradually, not exceeding 15 degree divergence wherever possible. Do not exceed 30-degree divergence upstream of equipment. Do not exceed 45-degree convergence downstream of equipment.
- x) For circular ducting all accessories viz bends, tees, reducers, flanges, etc shall be pre fabricated at the manufacturing unit as per SMACNA Standards. Construct Tees, bends, and elbows with a centerline radius 1.5 times the duct diameter. Where not possible and where rectangular elbows are used, provide single thickness turning vanes constructed and installed in accordance with SMACNA Standards.
- xi) FOR CIRCULAR DUCTS
 - a) Machine made spiral lock-seam duct with light reinforcing corrugations. Corrugations shall be applicable as per SMACNA Standards.
 - b) Fittings: Welded seam construction, manufactured of at least two gages heavier metal than duct.
 - c) The diameters of the spiral duct shall confirm to EUROVENT / ISO / CEN standards.
 - d) All branch connections shall be made as a separate fitting.
- d) All elbows shall be fabricated with a centerline radius of 1.5 times the diameter. 90° and 45° elbows in diameters 3" round through 5" round shall be stamped or pleated elbows.
- e) All other elbows shall be of the segmented type, fabricated in accordance with the following:

DEGREE OF ELBOW/ NUMBER OF SEGMENTS

DEGREE OF ELBOW	NUMBER OF SEGMENTS
less than 36°	2
37 thru 71 °	3
72 thru 90°	4

- f) Circumferential and longitudinal seams of all fittings shall be a continuous weld or spot welded and sealed with mastic. All welds shall be as per the HVAC Specification DW/144 and painted to prevent corrosion.
- g) All field joints for round ducts up to and including 900 mm diameter shall be made with a 50 mm slip-fit or slip coupling.

11.4 INSTALLATION OF DUCTS

- i) The fabrication and installation shall be done in a workmanlike manner. Duct work shall be rigid and straight without kinks.
- ii) All exposed ducts within the conditioned space shall have slip joints. Flanged joints shall not be used.
- iii) All joints shall be airtight.
- iv) Ducts shall be supported independently from the building structure and adequately, to keep the ducts true to shape. The support spacing shall be not more than 2 m. Where ducts cannot be suspended from ceiling, wall brackets or other suitable arrangements, as approved by the Engineer-in-charge shall be adopted. Neoprene or other vibration isolation packing of minimum 6 mm thickness shall be provided between the ducts and the angle iron supports/brackets. Vertical duct work shall be suitably supported at each floor by steel structural members.
- v) Where metal ducts or sleeves terminate in woodwork, tight joints shall be made by means of closely fitting heavy flanged collars. Where ducts pass through brick or masonry openings, wooden frame work shall be provided within the openings and the crossing ducts shall be provided with heavy flanged collars on either side of the wooden frame work, so that duct crossing is made leak-proof.
- vi) Duct connections to the air-handling unit shall be made by inserting a double canvas sleeve 150 mm long. The sleeve shall be securely bonded and bolted to the duct and unit casing.
- vii) Dampers shall be provided in branch duct connections for proper volume control and balancing the air quantities in the system, whether indicated in the drawings or not. Suitable links, levers and quadrants shall be provided for proper operation, control and setting of the dampers. Every damper shall have an indicating device clearly showing the position of the dampers at all times.
- viii) During construction, install temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- ix) Use double nuts and lock washers on threaded rod supports.

- x) Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- xi) Provide flexible connections with minimum 25 mm slack immediately adjacent to equipment in ducts associated with fans and motorized equipment.
- xii) Repair damaged galvanized ductwork surfaces (welds, scratches, etc.) by applying minimum 2 coats of a zinc base paint.
- xiii) Provide duct drops to diffuser same size as diffuser neck size.
- xiv) Install openings in ductwork where required to accommodate thermometers and controllers. Where openings are provided in insulated ductwork, install insulation material inside metal ring.

11.4 BALANCING

The entire air distribution system shall be balanced with the help of an anemometer. The measured air quantities at fan discharge and at the various outlets shall be within ± 5 percent of those specified / quoted. Branch duct adjustments shall be permanently marked after the air balancing is completed so that these can be restored to their correct position if disturbed at any time.

11.6 MEASUREMENT

- i) Duct measurements (for insulated ducts) shall be taken before application of insulation.
- ii) Duct work shall be measured section wise on the basis of external surface area by multiplying the axial length from flange face to flange face for each section by the corresponding duct perimeter in the centre of that section length.
- iii) Uniformly tapering straight sections shall also be measured as in (ii) above. However, for special pieces like tees, bends etc. area computations for surface areas shall be done as per shape of such pieces.
- iv) The quoted unit rate for external surfaces of ducts shall include all wastage allowances, flanges, gaskets for joints, vibration isolators, bracings, hangers and supports, inspection chambers/access panels, splitter dampers with quadrants and levers 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.
- v) Grilles and diffusers (except linear diffusers) shall be measured by the cross sectional areas, perpendicular to the airflow, and excluding the flanges. Volume control dampers, where provided shall not be separately accounted for.

- vi) Linear slot type diffusers shall be measured by linear measurements only, and not by cross-sectional areas, and shall exclude flanges for mounting of the linear diffusers. The supply air plenum for linear diffusers shall be measured as described above for ducting.
- vii) Fire dampers shall be measured by their cross sectional area perpendicular to the direction of the airflow. Quoted rates shall include the necessary collars and flanges for mounting, inspection pieces with access door and fusible link arrangement.

12.0 GRILLES / DIFFUSERS

SCOPE

The scope of this section is the supply, installation, testing and commissioning of air grills and diffusers.

- i) Grilles/diffusers shall be fabricated of extruded aluminium sections and shall present a neat appearance and shall be rigid with mechanical joints.
- ii) Square and rectangular grilles shall have a flanged frame with the outside edges curved 5 to 7 mm. The outer framework of the grilles shall be made of not less than 1.6 mm thick aluminium sheet. The louvers shall be of aerofoil design of extruded aluminium section with minimum thickness of 0.8mm at front and shall be made of 0.8mm thick aluminium sheet. Louvers may be spaced 18 mm apart.
- iii) Square and rectangular diffusers shall have a flange flush with the ceiling into which it is fitted or shall be of anti smudge type. The outlets shall comprise an outer shell with duct collar and removable diffusing assembly. These shall be suitable for discharge in one or more directions as required. The outer shell shall not be less than 1.6 mm thick extruded section aluminium sheet. The diffuser assembly shall not be less than 0.80 mm thick extruded aluminium section.
- iv) Circular diffusers shall have either flush or anti smudge outer cone. Flush outer cones shall have the lower edge of the cone not more than 5mm below the underside of the finished ceiling into which it is fitted. Anti smudge cones shall have the outer cone profile designed to reduce dirt deposit on the ceiling adjacent to the air outlet. The metal sheet used for construction of these shall be minimum 1.6 mm thick extruded aluminium sheet.
- v) Linear slot type diffusers shall have a flanged frame with the outside edges curved 3.5mm and shall have the required number of slots. The air quantity through each slot shall be adjustable. The metal sheet used for the construction of these shall be minimum 1.6 mm thick extruded aluminium sheet.

- vi) Grilles and diffusers constructed of extruded aluminium sections shall have grille bars set straight, or deflected as required. These shall be assembled by mechanical interlocking of components to prevent distortion.
- vii) All supply air grilles/diffusers shall be fitted with a volume control damper, made of MS sheets. The damper blades shall be pivoted on nylon bushes. These dampers shall be located immediately behind the grille/diffuser and shall be fully adjustable from within the occupied space without removing the grille/diffuser. The volume control damper for circular outlets shall be opposed blade radial/shutter type dampers. Opposed blade dampers shall be used for square and rectangular grilles/diffusers.
- viii) The locations of the grilles/diffusers are shown in the tender drawings. Necessary openings and wooden framework for fixing the grilles shall be provided by the air conditioning contractor. The location of grilles/diffusers is subject to change; hence the approval of the Engineer-in-Charge shall be obtained before finally fixing the grilles/diffusers in position.
- ix) While installing grills, the fasteners should be fixed in recessed grooves so that they are not visible on the flange or face of the grille/diffuser. Only non-ferrous screws shall be used.
- x) The grilles/diffusers shall be powder coated to the desired colour to match the surroundings wall/ceiling. The paint colour shall be approved by the Engineer-in-Charge.
- xi) All damages to the finish of the structure during the installation work shall be made good by the air-conditioning contractor before handing over the installation.

11.0 FRESH AIR INTAKES

SCOPE

The scope of this section is the supply, installation and commissioning of Fresh air Intakes.

- i) A fresh air intake cowl of GS sheet metal of square/rectangular shape and having a bend of 45 deg. angle to prevent rain water entry, shall be provided on the external wall.
- ii) The above cowl shall be provided with a bird screen made of GI wire mesh of 18 swg thick wire and having 6 mm holes. This screen shall be fixed tight to a flange on the outer edge of the cowl with 6mm GI bolts and nuts.
- iii) An opposed blade Volume Control Damper fabricated out of MS sheet and powder coated shall be fixed on the inner wall of the fresh air opening. The adjustable louvers shall be pivoted on nylon bushes. The

damper shall be provided with an easily operable lever with a locking arrangement. The damper and cowl shall be of the same face area.

12.0 FIRE DAMPERS

SCOPE

The scope of this section is the supply and installation of Fire dampers.

- i) Fire dampers shall be provided in all supply air ducts and return air path in the air-handling unit room and at all floor crossings. Access door will be provided in the duct before each set of fire dampers.
- ii) Fire dampers shall be multi blade louvers type. The blade should normally remain in the open position and shall allow maximum free area to reduce pressure drop and noise in the air passage. The blades and frame shall be constructed with minimum 1.6mm thick galvanized steel sheet.
- iii) The louvers of the fire damper shall be held in the open position by means of a fusible link made of two copper metal strips soldered together in an overlapping position, using a certified low-melting point solder. A heavy duty spring would ensure that the louvers are shut tight when the fusible link melts. The louver blades shall be pivoted on gun metal bushes.
- iv) Fire dampers shall have a rating of 90 minutes against collapse and flame penetration as per UL 555-1995.

15.0 WATER PIPING

SCOPE

The scope of this section is the supply, installation, testing and commissioning of the water piping system complete.

15.1 PIPING DESIGN

Pipe sizes shown in the tender documents are for guidance only. The contractor shall be responsible for selection of sizes as per detailed engineering to be done by him. Piping design to be done by the Air-conditioning contractor shall conform to the following:

- i) For water pipe sizing 50mm and below
Maximum friction : 4 Ft/100 Ft. Run
For pipe sizing 50mm and above
Maximum friction : 6 Ft/100 Ft. Run
- ii) Butterfly / Ball valves shall be provided at
 - a) suction and delivery sides of pumps.
 - b) Inlet and outlet of each Condenser, chiller and cooling tower.
 - c) all drain connections from equipments, except condensate drains.
 - d) Inlet & outlet of all the cooling coils of the AHUs and FCUs.

- iii) Non return valve shall be provided at the delivery of each pump. This shall be of swing type.
- iv) Balancing valve shall be provided at the outlet side of chiller, condenser, and the AHU cooling coils to regulate the water flow rate.
- v) Air valves of 25 mm size shall be provided at all high points in the piping system for venting of air.
- vi) Piping drawings showing the sizes of valves, layout and other details shall be prepared and submitted for the approval of the Engineer-in-charge before execution the work.

15.2 PIPE MATERIAL

Pipes shall be of the following materials.

Chilled Water Pipes

- a) Mild steel heavy class (Black steel) tube conforming to IS: 1239 for sizes upto 150mm.
- b) Welded black steel pipe, class 2, conforming to IS: 3589, for sizes greater than 150mm. These pipes shall be factory rolled & fabricated from minimum 6mm thick M.S. sheet for pipes upto 350mm dia & from minimum 8mm thick M.S. sheet for pipes of 400mm dia & above.

Condenser Water Pipes

- c) Galvanized steel heavy class tube conforming to IS: 1239 for sizes up to 150mm.
- d) Galvanized welded steel pipe, class 2, conforming to IS: 3589, for sizes greater than 150mm. These pipes shall be factory rolled & fabricated from minimum 6mm thick M.S. sheet for pipes up to 350mm dia & from minimum 8mm thick M.S. sheet for pipes of 400mm dia & above. The pipes shall be hot dip galvanized after fabrication and successful pressure testing.

15.3 PIPE JOINTS

Joints in steel pipes shall be of any of the following types.

- a) Screwed joints and union joints screwed to pipes or welded joints, up to 25mm size.
- b) Butt welded joints for pipe sizes above 25mm.
- c) Flanges joints with flanges as per IS: 6392 for all sizes. Flanges may be steel welded neck type or slip on type welded to pipe, or alternatively screwed type.

15.4 VALVES

- i) The material of construction of butterfly valves shall be as under:

Body	-	Cast iron
Disc	-	Cast Bronze or Stainless Steel
Seat	-	Nitrile rubber
O-ring	-	Nitrile rubber / Silicon
- ii) Balancing valve shall be of cast iron flanged construction with EPDM / SG iron with epoxy coated disc with built in pressure drop measuring facility (pressure test cocks) to compute flow rate across the valve. The test cocks shall be long enough to protrude out of pipe insulation.
- iii) Non return valves shall be of gun metal construction upto 65mm, the metal conforming to class 2 of IS: 778. For 75mm and above, the valve shall be of bronze or gun metal, body being of cast iron. While screwed or flanged ends may be provided upto 65mm, flanged ends shall be provided for larger sizes.
- iv) Air purge valves shall be of gunmetal body.

15.5 STRAINERS

- i) Strainers shall be of 'Y' type. 'Y' strainers shall be provided on the inlet side of each air-handling unit and pump in chilled water and condenser water circuit. The strainers shall be designed for the test pressure specified for the gate valves. Filtration area of Y-strainer shall be minimum four times the connecting pipe size.
- ii) Strainers shall have a removable bronze / stainless steel minimum 1mm thick screen with 3 mm perforations and permanent magnet. Strainers shall be provided with flanges or threaded sockets as required. They shall be designed so as to enable blowing out accumulated dirt and facilitate removal and replacement of screen without disconnection of the main pipe.

15.6 INSTRUMENTS

- i) Pressure gauge of appropriate range and 100mm. dial size shall be provided at the following locations.
 - a) Supply and return of all heat exchange equipments.

The pressure gauge shall be duly calibrated before installation and shall be complete with shut off cocks.
- ii) Direct reading industrial type thermometer of appropriate range shall be provided at the inlet and outlet of all heat exchange equipments. The thermometers shall be installed in separate wells.

15.7 EXPANSION TANK

- i) Expansion tank for chilled water shall be of closed pressurized type. The tank shall be of 1000 liters capacity and shall be of MS sheet construction. It shall be provided with a special membrane of synthetic material to withstand the system pressurization. The tank shall be insulated with 50 mm thick eps slabs and covered with wire netting and cement plastering.
- ii) A pressurization system shall be provided along with the expansion tank. This system shall consist of two make-up water pumps, one working and one standby. The pumps shall be multi stage centrifugal pumps capable of operating at the chilled water operating pressure. The system shall be complete with pressure switch, isolating valves, non-return valves and make-up water piping from the tank located on the roof of the AC plant room. The two pumps shall be mounted on a common MS base frame and mounted on a masonry pedestal.
- iii) An air separator shall be provided at the suction side of the primary chilled water pumps. The capacity of the air separator shall be compatible with the system capacity and the size of the water inlet and outlet flanges shall be as per the size of the main chilled water header pipes. The air separator shall be insulated with 50 mm thick eps slabs and covered with wire netting and cement plastering. The air separator shall be provided with an automatic air vent.

15.8 INSTALLATION

- i) The installation work shall be carried out in accordance with the detailed drawings prepared by the Air-conditioning Contractor and approved by the Engineer-in-charge.
- ii) Air-conditioning contractor shall utilize the structural provisions for Air-conditioning services wherever provided in the building and make his own arrangements for additional changes.
- iii) Expansion loops or joints shall be provided to take care of expansion or contraction of pipes due to temperature changes.
- iv) Tee-off connections shall be through equal or reducing tees, otherwise ferrules welded to the main pipe shall be used. Drilling and tapping of the walls of the main pipe shall not be resorted to.
- iv) Wherever reducers are to be made in horizontal runs, eccentric reducers shall be used if the piping is to drain freely. In other locations, concentric reducers may be used.
- vi) Open ends of piping shall be blocked as soon as the pipe is installed to avoid entry of foreign matter.

- vii) All pipes using screwed fittings shall be accurately cut to the required size and threaded in accordance with IS: 554 and burrs removed before laying.
- viii) Piping installation shall be supported on or suspended from the building structure adequately. The Air-conditioning contractor shall design all brackets, saddles, clamps, hangers etc. and shall be responsible for their structural integrity.
- ix) Pipe supports shall be of steel, adjustable for height and prime-coated with zinc chromate paint and finish-coated gray. Spacing of pipe supports shall not be more than that specified below:-

Nominal Pipe size (mm)	Spacing (Metres)
12 and 15	1.25
20 and 25	2.00
32, 40, 50 and 65	2.50
80, 100 and 125	2.50
150 and above	3.00

Extra supports shall be provided at the bends and at heavy fittings like valves to avoid undue stress on the pipes. Pipe hangers shall be fixed on walls and ceiling by means of metallic or Rawl plugs or approved shear fasteners.

- x) Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation.
 - xi) Anti vibration pads, springs or liners of resilient and non-deteriorating, material shall be provided at each support, so as to prevent transmission of vibration through the supports.
 - xii) Pipe sleeves of diameter larger than the pipe by at least 50mm shall be provided wherever pipes pass through walls, and the annular spaces shall be filled with felt and finished with retaining rings.
 - xiii) a) Vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Risers passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe with a 12mm thick rubber pad or any other resilient material as approved by the Engineer-in-charge.

b) The space in the floor cut outs around the pipe work (after insulation work where applicable) shall be closed using cement concrete (1:2:4 mix) or steel sheet, from the fire safety considerations, taking care to see that a small annular space is left around the pipes to prevent transmission of vibration to the structure.

- c) Risers shall have suitable support at the lowest point.
- xiv) Where pipes are to be buried under ground, the top of the pipes shall be not less than 75 cms from the ground level. Where this is not practicable, permission of the Engineer-in-charge shall be obtained for burying the pipes at a lesser depth. The pipes shall be surrounded on all sides by sand cushion of not less than 15cms thickness. After the pipes have been laid and top sand cushion provided, the trench shall be refilled with the excavated soil and any extra soil shall be removed from the site of work by the Air conditioning contractor.
- viii) All pipes and their steel supports shall be thoroughly cleaned and given one primer coat of Zinc chromate before being installed.
- xvi) After all the water piping has been installed, pressure tested in accordance with clause 10.10, all exposed piping in the plant room shall be given two finish coats of paint, approved by the Engineer-in-charge. Similar painting work shall be done over insulated pipe work, valves etc. The direction of flow of fluid in the pipes shall be indicated with identification arrows.
- ix) 3 mm gasket shall be used for flanged joints.

15.9 PRESSURE TESTING

- i) All 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 Engineer-in-charge.
- ii) Piping repaired subsequent to the above pressure test shall be re-tested in the same manner.
- iii) System may be tested in sections and such sections shall be securely capped.
- v) It shall be made sure that proper noiseless circulation is achieved through all the coils and other heat exchange equipments in the system. 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 the above rectification.

- v) Insulation shall be applied to piping only after the completion of the pressure testing to the satisfaction of the Engineer-in-charge.
- vi) Pressure gauges may be capped off during pressure testing of the installation.

- vii) The contractor shall provide all materials, tools, equipments, instruments, services and labour required to perform the tests and to remove water resulting from cleaning after testing.

15.10 BALANCING

- i) After completion of the installation, the entire water system shall be adjusted and balanced to deliver the water quantities as specified, quoted, or as directed.
- ii) Automatic control valves and two way diverting valves shall be set for full flow condition during balancing procedure. Water circuit shall be adjusted by balancing cocks provided for balancing. These shall be permanently marked after the balancing is completed so that they can be restored to their correct positions, if disturbed.

15.11 MEASUREMENT

Measurement of piping work shall be done on the following basis:-

- a) Piping shall be measured along the centre line of installed pipes including all pipe fittings and accessories but excluding valves and other items for which quantities are specifically indicated in the schedule of work. No separate payment shall be made for fittings and accessories.
- b) The rates for piping work shall include all wastage allowances, pipe supports, hangers, nuts and check nuts, vibration isolators, suspension where specified or required, and any other item required to complete the piping installation. These items shall neither be separately measured nor paid for.
- c) Piping measurement shall be taken before application of the insulation in the case of insulated pipe work.

16.0 INSULATION WORK

SCOPE

The scope of this section is the supply and installation of insulation work.

16.1 MATERIAL

The insulation material to be used for various applications shall be as follows:

- i) For insulation of water piping, pumps and tanks:-
Fire retardant quality Expanded Polystyrene moulded pipe sections shall be used for pipes and slabs for other equipments.
- ii) For thermal Insulation of duct work:-
 - a) Fiber glass mat covered with aluminium foil.
 - b) Nitrile rubber sheet

- iii) For acoustic lining of ducts
Fiber glass rigidboard covered with RP tissue and perforated aluminium sheet.
- iv) For acoustic lining of AHU rooms:-
Fiber glass mat
- v) For suction line and Chiller insulation:-
Polyvinyl nitrile rubber insulation.
- vi) For double skin AHUs:
Polyurethane foam (PUF)

16.2 MATERIAL SPECIFICATION

The insulation material shall satisfy the following requirements:

- i) For thermal application on pipes.

Material	Minimum Density (Kg/cu.m)	Maximum Thermal conductivity (K.cal/hr. degree C/m at 10 deg C mean temp.)
Fire retardant quality EPS	24	0.031

- ii) For thermal insulation of ducts:

<u>Material</u>	<u>Minimum Density (Kg./Cub.M)</u>
Fiber glass mat	24
Nitrile rubber sheet	

Fiber Glass Insulation used for duct insulation shall be factory faced with aluminium foil on one side, reinforced with Kraft paper & fused to the insulation material.

- iii) For acoustic lining:

Application	Material	Minimum Density (Kg./Cu.M)
Duct	Fiber glass rigidboard	48
AHU room	Fiber glass mat	24

- iv) The fiber glass mat and rigidboard shall be as per IS 8183 as amended up to date.
- v) Expansion tank Insulation: Fire retardant EPS slabs of density not less than 24 kg per cum.

16.3 INSULATION THICKNESS

The thickness of insulation shall be as indicated below.

- i) For insulation of chilled water pipes, fittings etc.

Pipe Size (mm)	EPS moulded pipe sections - thickness (mm)
All pipe sizes	50

- ii) For Duct insulation

Application	Fiber glass mm	Nitrile rubber mm
Thermal for AC area	25	12
Thermal for Non AC area	50	25
Acoustic	12	NA

- iii) For room acoustic lining

Fiber glass mat 50 mm

- iv) For pumps & Expansion tank:

EPS slabs 50 mm

- v) Chiller Insulation

Thickness of polyvinyl rubber insulation used for chiller insulation shall not be less than 19 mm.

16.4 APPLICATION OF INSULATION ON PIPES

- i) The surface to be insulated shall be first cleaned and a coat of shalikota or equivalent shall be given. The insulation shall be fixed tightly to the surface with hot bitumen/cold setting adhesive CPRX compound as recommended by the insulation manufacturer. All joints shall be staggered and sealed.

- ii) The insulation shall be finished as under:

- Chilled water piping inside the building and External above Ground. Duly insulated with EPS pipe section insulation and covered with one layer of polythene sheet, one layer of GI wire netting of 24 swg and 20 mm holes, one layer of sand cement plaster 20 mm thick smoothly finished and two coats of cement paint.
- Chilled water piping outside the building buried in ground. Duly insulated with EPS pipe section insulation and covered with one layer of polythene sheet, one layer of GI wire netting of 24 swg and 20 mm holes, one layer of sand cement plaster 20 mm thick smoothly finished and covered with one layer of Grade 1 tarfelt 3.5 mm thick, suitably overlapped and joints sealed with CPRX compound.

- iii) All valves, fittings, strainers 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.

16.5 APPLICATION OF INSULATION ON PUMPS AND EXPANSION TANK

Fire retardant Expanded Polystyrene slabs of 50 mm thickness, polythene sheet, GI wire netting 24 swg thick and with 20 mm holes and sand cement plastering.

16.6 APPLICATION OF THERMAL INSULATION ON DUCT

- i) The surface of duct on which the external thermal insulation is to be provided shall be thoroughly cleaned with wire brush and rendered free from all dust and grease.
- ii) Two coats of cold compound adhesive (CPRX compound) shall be applied over the duct. Any other adhesive recommended by the manufacturers may also be used with the approval of the Engineer-in-charge.
- iii) The nitrile rubber or the eps insulation material shall be tightly stuck on the duct surface without any air gaps. In the case of the eps insulation one layer of aluminium foil shall be tightly wrapped over the insulation and fastened with binding straps at one metre intervals. All joints shall be sealed with BOPP tape.
- iv) The ducts in areas exposed to the weather shall be additionally covered with one layer of tar felt conforming to IS: 1322 Type 3 Grade-1. The tar felt shall be stuck with Hot Bitumen.

16.7 APPLICATION OF DUCT ACOUSTIC LINING

- i) The Inside surface of duct on which the acoustic lining is to be provided shall be thoroughly cleaned with wire brush and rendered free from all dust and grease.
- ii) RP tissue shall be stuck on one side of the fiberglass rigidboard slabs using fevicol or equivalent adhesive.
- iii) The rigidboard with RP tissue shall be stuck to the inner sides of the duct with adhesive.
- iv) Perforated aluminium sheet of 26 swg thick and having a minimum of 30 % perforation area shall be laid over the rigidboard slabs with suitable overlaps and with the edges folded down on the two open ends of the duct. The entire insulation shall be rigidly held in place by means of GI screws, nuts and washers that are inserted through the duct sheet at intervals of 50 cms.

16.8 MEASUREMENT OF INSULATION

- i) Pipe insulation shall be measured in units of length along the centre line of the insulated pipe. The linear measurements shall be taken before the application of the insulation. For piping measurements, all valves, orifice plates and strainers shall be considered strictly by linear measurement along the centre line of the pipes, and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.
- ii) 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 thermal insulated or acoustically lined duct shall be based on the perimeter at the centre of thickness of insulation, multiplied by the centre-line length of ducting including tapered pieces, bends, tees, branches etc. as measured for bare ducting. In the case of tapering pieces, their average perimeter shall be considered.

16.9 UNDERDECK INSULATION

The underside of the ceiling must be cleaned thoroughly. Rawl plugs and hooks shall be fixed on to the ceiling at a spacing of 1 meter in one direction 0.5 metre in the other direction. GI wire shall be inserted into the hooks in the ceiling and extended to about 150 mm length. Fire retardant EPS slabs of 24Kg/cu.m density and 50 mm thick shall be stuck to the under side of the ceiling using suitable adhesive, such that the GI wire extensions are left at each corner of the EPS slabs. GI washers of 50 mm square cut from 24 swg thick sheets, and with their corners upturned shall be pierced into the eps slabs at the corners such that each GI washer supports four slabs. The GI wire extensions are drawn out through a hole in the middle of the washer and is twisted tight to secure the washer and the corners of the four slabs tight against the ceiling.

17.0 QUALITY ASSURANCE

17.1 Inspection and testing

- I. All equipment and components supplied may be subjected to inspection and tests by the Consultants during manufacture, erection/installation and after completion. The inspection and tests shall include but not be limited by the requirements of this contract document. Prior to inspection and testing, the equipment shall undergo pre-service cleaning and protection.
- II. Tenderers shall state and guarantee the technical particulars listed in the Schedule of Technical Data. These guarantees and particulars shall be binding and shall not be varied without the written permission of the Consultants.
- III. No tolerances shall be allowed other than the tolerances specified or permitted in the relevant approved Standards, unless otherwise stated.
- IV. If the guaranteed performance of any item of equipment is not met and / or if any item fails to comply with the specification requirement in any

respect whatsoever at any stage of manufacture, test or erection, the Consultants may reject the item, or defective component thereof.

17.2 Performance

It is the Tenderer's responsibility to ensure that the entire HVAC system as a whole and all its individual components deliver the specified levels of performance, reliably and continuously. The Quality Assurance will include but not be limited to the following criteria.

- i. Verification of design conformity.
 - ii. Establishing that the fluid flow rates, volumes and operating pressures are as specified.
 - iii. Ensuring that the energy consumption of all the relevant components of the system are as specified.
 - iv. Establishing that the operating sound and vibration levels are within the specified limits.
 - v. Adjusting and balancing the various systems as per the design parameters.
 - vi. Recording and reporting the results as per the specified formats.
-

18. DIVISION OF WORK

The Division of Work between the Client and the Contractor will be as follows.

Client's scope of work.

1. Civil works like construction of AC plant room, AHU rooms and trenches for pipelines.
2. False ceiling, including trap doors for ceiling suspended units and frames for fixing grills/diffusers
3. Electrical work for the Air-conditioning system, including switch board, switch gear, cables and earthing.
4. Providing storage space at site for materials and equipments during the installation period.
5. Providing water and power supply for installation, testing and commissioning of the AC system.

Contractor's scope of work.

1. Supply, installation, testing and commissioning of all the equipments and services listed out in the Technical specifications and the Bill of Quantities.

2. Providing the tools, tackles, ladders, scaffolding etc. required for the installation of the AC work.
3. Carrying out minor civil works like masonry pedestals for the equipments and breaking and making good wall openings for routing pipes, ducts etc.
4. Providing security at site for the equipments and materials till the plant is handed over to the Users.
5. The HVAC contractor must give his concurrence for the design and selection of switch gear, cables, earthing etc. by the Electrical contractor, with respect to the Electrical works of the Air-conditioning system. The HVAC contractor must also guide the Electrical contractor and render any supervisory assistance that may be required during the execution of the said work.
6. All working drawings with respect to the HVAC works will be prepared by the HVAC Contractor and approved by the Architects/Consultants, before commencement of work.

APPENDIX - I

LIST OF BUREAU OF INDIAN STANDARDS CODES

IS : 277 - 1992	Galvanized steel sheet
IS : 655 - 1963 (Reaffirmed 1991)	Metal air ducts.
IS : 659 – 1964 (Reaffirmed 1991)	Air conditioning (Safety Code)
IS : 660 – 1963 (Reaffirmed 1991)	Mechanical Refrigeration (Safety Code)
IS : 780 - 1984	Sluice valves for water works purposes.
IS : 822-1970 (Reaffirmed 1991)	Code of procedure for inspection of welds.
IS : 1239 (Part - I) - 1990	Mild steel tube
IS : 1239 (Part - II) - 1992	Mild steel Tubulars and other wrought steel pipe fittings.
IS : 2379 - 1990	Colour code for the identification of pipelines.
IS : 3103 – 1975 (Reaffirmed 1999)	Code of practice for Industrial Ventilation.
IS : 4736 – 1986 (Reaffirmed 1998)	Hot-dip zinc coatings on steel tubes.
IS : 4894 - 1987	Centrifugal Fan.
IS : 5312 (Part-I) - 1984 (Reaffirmed 1990)	Swing-check type reflux Non return valves for water works
IS : 6392 - 1971(Reaffirmed 1988)	Steel pipe flanges.
ASHRAE Hand Books	The Latest versions and standards.

APPENDIX - II

INFORMATION REQUIRED WITH TENDER

WATER CHILLING PACKAGE – SCREW TYPE

1. Make/Model
2. Refrigerant
3. Capacity (Kcals/hr.) at rated conditions
4. Input power at above capacity
5. Type of capacity control
6. Condenser surface area
Refrigerant side
Water side
7. Condenser water flow rate
8. Condenser water temp. drop
9. Condenser water pressure drop
10. Chiller surface area
Refrigerant side
Water side
11. Chilled water flow rate
12. Chilled water temp. drop
13. Chilled water pressure drop

COOLING TOWERS

1. Make/model
2. Water flow rate
3. Water temperature drop (at 28° C WB.)

CONDENSER WATER PUMPS

1. Make / model
2. Type
3. Water flow rate/ Total head
4. Operating speed

CHILLED WATER PUMPS

1. Make / model
2. Type
3. Water flow rate/ Total head
4. Operating speed

AIR HANDLING UNITS

1. Make
2. Make of fan motor

APPENDIX - III

TEST READINGS

S.NO	ITEM	TEST RESULTS
1.	Chiller (each circuit)	
	a. Refrigerant gas suction pressure (ksc)	
	b. Refrigerant discharge pressure (ksc)	
	c. Input Kw at full load	
2.	Cooling tower	
	a. Entering water temperature..... (deg. C)	
	b. Leaving water temperature (deg. C)	
	c. Water flow rate (Lps)	
3.	Condenser water pumpsets	
	Flow rate (LPS)	
	Discharge Pressure (ksc)	
	Suction Pressure (ksc)	
4.	Chilled water pumpsets	
	Flow rate (LPS)	
	Discharge Pressure (ksc)	
	Suction Pressure (ksc)	
5.	Air-handling unit (for each AHU)	
	a. Fresh air quantity (cfm)	
	b. Return air quantity (cfm)	
	c. Total air quantity at inlet (cfm)	
	d. Fresh air temp. (deg. F) dry/wet Bulb	
	e. Entering air temp. (deg. F) " "	
	f. Leaving air temp. " " "	
	g. Static pressure at fan discharge (inch wg.)	
	h. Current (amps)	

9. TESTING OF HVAC INSTALLATIONS

After the completion of the work all testing required have to conduct as per CPWD Specifications 2004.

SECTION V
A. FIRE PROTECTION SYSTEM

1.1.0 SCHEME:

The proposed Super Specialty Hospital to be constructed at Madurai under PMSSY.

The tenderers are advised to visit the site for familiarization of site conditions and collection of any information considered vital for submission of tender.

1.2.0 SCOPE OF WORK:

The scope of work and services to be rendered by the tenderer for the supply, installation and commissioning of the Fire Protection System as per CPWD specification for Electrical works Part V 2006 (Wet Riser and Sprinkler System) and also TAC norms to be followed with the following activities.

- a. 1 No. Motor driven 137 M3/hr. at 70 MWC main pump set, 1 No. Diesel Engine driven 137 M3/hr. at 70MWC standby pump set and 1 No. 10.8M3/hr. at 70 MWC Jockey pump set with complete accessories such as diesel engine control panel, fuel tank, battery charger, batteries, motor control center, base frames, foundation bolts, couplings, coupling guards, pressure gauges, pressure switches, addressable fire alarm system, fire extinguishers and any other components for the satisfactory operation of the system.
- b. Fire hydrants are provided around the building at every 45 meters along the perimeter of the building. Each and every hydrant is provided with fire hose cabinet consisting of firefighting hoses with couplings and branch pipe, and internal hydrant of wet riser comprising of fire hydrant valves at each floor and first aid hose reels, firefighting hoses, branch pipes including all associated piping and etc.
- c. All civil and structural works related to the job.
- d. All electrical works related to the work.
- e. Controls and instrumentation.
- f. Painting of above ground pipes.
- g. Shop and site painting of equipment and pipes.
- h. Any other facilities to complete the system in all respects for its satisfactory performance as directed by the purchaser / consultants.

1.3.0 DRAWINGS

The drawings are available with the client/HLL for the general guidance to the tenderers. The contractor shall upon the award of the work, furnish the working drawings, detailed product catalogues and the details of installation materials. These shall be submitted for approval to the EIC/Consultant. The work shall be commenced only after the approval of drawings, products and installation materials by the EIC/Consultant. The contractor to coordinate all the drawings with various services drawings of the project before executing the job.

1.4.0 INSPECTION AND APPROVAL

The contractor shall arrange all necessary inspection by the Local authority. He shall also arrange to conduct all the tests before obtained approval from the client/EIC. The contractor responsibility to prepare and submit the documents of the test that he is going to conduct and it is witnessed by all the parties with their signature, designation in the submitted documents.

1.5.0 PAINTING

All piping, equipment, cabinets furnished under this specification shall be properly painted with one coat of zinc chromate primer and two coats of synthetic enamel paint after installation and shall meet the requirements as outlined in Fire Protection Manual. Paint used for this work will be lead free quality. The cost of painting deems to be inclusive in the respective items.

1.6.0 GUARANTEE:

The contractor shall guarantee the material and workmanship of the entire systems are of first class quality and shall correspond to standard engineering practice. All the equipments/apparatus shall be guaranteed to yield the specified rating and design capacities, speeds. Any defective equipment / material / workmanship found short of the specified quality shall be rejected. The contractor shall make good of the rejected items or supplied the new at his own cost. Guarantee/test certificate of equipment from suppliers/manufacturers shall be handed over to the Owner.

1.7.0 DEFECTS & LIABILITY:

All the equipment/ material and the system shall be guaranteed against defective material and workmanship for a period of 12 months from the date of commissioning and handing over the Owners along with all relevant documentation.

The contractor shall repair/ rectify or replace all the defective materials, components at free of cost.

1.8.0 Instruction Manual/Completion Drawings/Training:

The contractor shall furnish detailed instruction and operation manual in quadruplicate. The contractor shall also furnish detailed completion drawings (asbuilt) as soft copy and sepia drawn to an approved scale. The drawings shall be inclusive of control

schematic, if any. The contractor shall train the Employer's personnel in the operation and maintenance of the system for one month.

1.9.0 TESTING:

The contractor shall arrange to test the entire system as per the procedure enumerated under particular specifications, after the erection is completed. The tests shall be carried out to the satisfaction of EIC/Consultant. The results of the tests shall be submitted to the EIC/Consultant in quadruplicate. If the results of the tests are not found to be satisfactory by the EIC/Consultant, necessary rectifications shall be done until the test results are found to be satisfactory. The installation shall be deemed to be completed only after the successful completion of the tests.

1.10.0 TECHNICAL DATA:

The tenderers shall furnish data of their equipments as per the performance under Technical Data. The tenders without technical data are liable to be rejected.

1.11.0 REGULATIONS AND STANDARDS:

The work shall be carried out in accordance with the regulations of local bodies, if any and the following specifications and codes which may govern the requirements of the system.

- a) IS 901 : Specification for couplings, double male and double female, instantaneous pattern for fire fighting
- b) IS 903 : Specification for branch pipes and nozzles for firefighting purposes
- c) IS 13095 : Butterfly valve for water works purposes
- d) IS 1239 : Mild steel tube and other wrought steel fittings
- e) IS 3589 : Electrically welded steel pipes for water, gas and sewage
- f) IS 6392 : Steel pipe flanges
- g) IS 636 : Non - percolating flexible hose (RRL) for fire fighting
- h) IS 5290 : Landing valves
- i) IS 2871 : Branch pipe, universal for firefighting purposes
- j) IS 884 : First aid hose reel for fire fighting
- k) IS 2190 : Selection, Installation and Maintenance of Portable fire extinguishers
- l) IS 12349 : Fire Protection Safety sign
- m) IS 780 : Gate Valves for water works purpose

- n) T.A.C : Tariff Advisory Committee - Fire protection Manual
- o) NBC 2005 : National Building Code 2005
- p) UL/FM : Underwriter Laboratories/Factory Mutual
- q) IS 325 : Three phase induction motors
- r) IS 4029 : Guide for testing three phase induction motors
- s) IS 3043 : Code of practice for earthing
- t) IS 1520 : Horizontal centrifugal pumps for clear, cold and fresh water
- u) IS 1248 : Direct acting electrical indicating instruments
- v) IS 2509 : Rigid non-mettalic conduits for electrical wiring
- w) IS: 694 : PVC insulated cables
- x) IS: 2509 : Rigid-non-metallic conduits for electrical wiring
- y) IS: 3415 : Fittings for rigid non-metallic conduits
- z) IS: 5216 : Guide for safety procedures and practices in electrical work.

Note 1: All components of the hydrant/sprinkler system shall bear ISI/UL/FM mark wherever applicable and shall be of approved make. (List of approved make is enclosed as Annexure)

2.0 BRIEF DESCRIPTION & OPERATION OF THE SYSTEM

2.1.0 Fire Hydrant & Wet Riser System

The fire hydrant and wet riser system is fully automatic in operation. The fire hydrant and wet riser system piping is normally kept pressurized at 7 bars with the jockey pump. The jockey pump installed in the plant room will compensate any minor pressure loss in the pressurized pipeline. In case any internal hydrant valve or hose reel is opened, the water pressure in the pipe network will drop all of a sudden.

As the result, jockey pump cannot compensate this pressure drop, the respective main pump will start automatically at its preset pressure. If the respective main pump fails to start, the pressure in the piping will further drop down, resulting in automatic starting of the Diesel Engine driven pump at its preset pressure.

The switching ON and OFF of the jockey pump are automatic, whereas the main and standby pump will start automatically but to be switched OFF manually once the fire is completely extinguished.

Apart from that the emergency water tank is located in the top of the building and it has connected with all wet hydrant risers with a valve and the outlet of terrace fire water tank fitted with a check valve and a gate valve.

2.2.0 PUMPS

- i. The pumps and its components shall comply with the CPWD/TAC specifications.
- ii. The centrifugal pumps, with their auxiliary equipment, shall be suitable for the required duty conditions and shall be designed and manufactured for continuous operation at full load.
- iii. Pumps shall be capable of developing not less than 150% of rated capacity at a head of not less than 65% of rated head. The shut off head shall not exceed 120% of rated head.
- iv. The casing shall be made out of cast iron and shall be designed for a pressure not less than the shut off pressure at the highest operating speed or the maximum pressure that may be encountered at the pump inlet.
- v. The impeller shall be of bronze and statically and dynamically balanced.
- vi. Pumps shall be connected to the drive by means of spider / love-joy coupling, which shall be balanced dynamically and statically. The coupling joining the prime mover with the pump shall be covered with a sheet metal coupling guard.
- vii. Pumps shall be installed true to the level on suitable concrete foundation, surface grinding base plate.
- viii. Pumps and motors / engines shall be truly aligned by suitable instruments and as per instructions/guidelines issued by manufacturers.
- ix. All pumps shall conform to TAC regulations with respect to its material of construction and operational parameters.

2.3.0 DIESEL ENGINE DRIVES

- 2.3.1 The diesel engine shall be 4 stroke, stationary type, radiator cooled, cold starting type in accordance with CPWD/TAC specification.
- 2.3.2 The speed of the engine shall match the speed of the pump for direct drive. The engine shall be capable of taking full load within 15 seconds from receiving the signal to start.
- 2.3.3 The engine shall be capable of continuously delivering the rated output and shall run steadily at any load with its rated load. Suitable automatic governing system shall be provided. The diesel engine shall conform to ariff Advisory Committee (TAC) requirements and suitable for the climatic conditions prevailing at site.

- 2.3.4 The engine horse power for the pump shall be equivalent or more to the horse power required to drive the pump at 150% of the rated discharge at a head of not less than 65% of the rated head.
- 2.3.5 The engine starting system shall be with the help of lead acid batteries of adequate amp-hr capacity and electrical starter. The engine shall be suitable for both automatic and manual start. Normally the engine shall start automatically but in case of failure of auto start of the system, the engine shall be capable of Manual start. The engine shall be able to start without any preliminary heating of combustion chamber with provision of suitable cranking mechanism.
- 2.3.6 The self-motor fed by battery shall initiate automatic start of diesel engine. Starting power will be supplied from a set of 12/24 V storage batteries. The battery capacity shall be adequate for ten consecutive starts of a cold engine, without recharging. During starting of the engine, the charger shall be disconnected.
- 2.3.7 The fuel system shall be complete with all the required auxiliaries. Fuel tank fabricated out of 2-mm thick MS sheet suitable for 4 hours engine running. The engine shall be provided with filters in its fuel system.
- 2.3.8 The diesel engine shall be provided with dry type, low resistance air passage with high dust retaining efficiency air filter.
- 2.3.9 The engine shall be provided with exhaust silencer muffler suitable for low noise and exhaust emission levels and the required length of the exhaust piping. The exhaust piping shall be thermal insulated from heat radiation.
- 2.3.10 The engine shall be pressure lubricated, for which engine driven lubricating oil pumps of suitable capacity shall be provided. The lubricating oil system shall be suitable to lubricate the working parts of the engine effectively, with the recommended grade of oil. The engine shall be provided with appropriate lubricating oil filters and coolers. The lubricating oil system shall include protection device to the engine. As soon as lubricating oil pressure falls below a preset level, the sensing device shall give an audio-visual signal in the control panel. The lube oil pressure switch shall be provided along with gauges in the lubricating system.
- 2.3.11 The engine shall be provided with all the necessary instruments, including the following:
- Tachometer
 - Water temperature gauge
 - Lubricating oil temperature gauge
 - Lubricating oil pressure gauge
- 2.3.12 Any other instruments which are necessary for satisfactory operation of the diesel engine. The diesel engine shall meet all the requirements and specifications of the TAC.

Note: Contractor should select diesel engine to comply with clause 2.3.4 but not less than the 60HP at 1800 RPM for 137Cu.m/hr at 70MWC pump.

2.4.0 ELECTRICAL MOTORS

- 2.4.1 Electrically driven pump shall be provided with TEFC motor as per latest IS 325. The motor shall be rated not to draw starting current more than three to four times normal running current.
- 2.4.2 The motor for the pump shall be rated equivalent or more than the horse power required to drive the pump at 150% of the rated discharge at a head of not less than 65% of the rated head.
- 2.4.3 Motor shall be wound for Class F insulation and winding shall be vacuum impregnated with heat and moisture resistant varnish, glass fiber insulated to withstand tropical conditions.
- 2.4.4 Motor shall be suitable for 415V, 3 phase, 50HZ, AC supply and shall be capable of handling variations of 10% in voltage and $\pm 5\%$ in frequency.
- 2.4.5 Motor shall be capable of handling the required starting torque of the pumps.
- 2.4.6 The cable boxes and termination shall be designed to enable easy connection/disconnection and replacements of cables.
- 2.4.7 Two independent earthing points shall be provided on the opposite side of motors with proper lugs.

Note: contractor should select the motor for main pump to comply with technical specification clause no: 2.4.2 but not less than 55KW for 137Cu.m/hr at 70MWC pump and 9.3KW for 10.8Cu.M/hr at 70MWC jockey pump.

2.5.0 MOTOR CONTROL PANEL

- 2.5.1 Particulars of the system.

Operating voltage : 415V
Frequency : 50HZ
Phase : 3 phase

- 2.5.2 The design and construction of LT cubicle panel shall generally conform to CPWD/TAC specification.
- 2.5.3 The LT cubicle panel shall be fabricated out of 14 SWG sheet steel totally enclosed with separate cable chamber and busbar chamber, dust tight, vermin proof, weather proof, indoor, floor mounting type and shall have the following minimum requirements:
 - a. Incoming
 - i. suitable rating TPN SFU

- ii. Voltmeter with selector switch
- iii. Ammeter with selector switch
- iv. Set of CT's
- v. Set of Indicating lamps
- vi. Set of Control fuses

b. Outgoing for main pump motor

- i. Suitable rating TPN SFU with automatic Star Delta starter.
- ii. Ammeter with selector switch
- iii. Set of CT's
- iv. Over load relay
- v. Auto manual selector switch
- vi. ON/OFF/TRIP indicating lamps
- vii. START/STOP push buttons
- viii. Auxiliary contactor
- x. Pump ON audio-visual alarm.

c. Out going for jockey pump motor

- i. TPN SFU with automatic DOL Starter
- ii. Ammeter with selector switch
- iii. Set of CT's
- iv Over load relay
- v. Auto manual selector switch
- vi. ON/OFF/TRIP indicating lamps
- vii. START/STOP push buttons
- viii. Auxiliary contactor
- ix. Pump ON audio-visual alarm.

d. Out going for dewatering pump motor

- i. TPN MCCB with DOL Starter
- ii. Auto manual selector switch
- iii. ON/OFF/TRIP indicating lamps
- iv. START/STOP push buttons

- a. Suitable out going feeders for diesel engine control panels cum battery charger.

2.5.4 The bus bars shall be air insulated and made of high conductivity, high strength aluminum alloy complying with requirements of grade E91E of IS:5082 and suitable for 415 Volts, 4 wire 50HZ system.

2.5.5 The bus bars shall be liberally sized and shall have uniform cross section throughout and shall be capable of carrying the rated current at 415V continuously. The bus bars shall be designed to withstand a temperature rise of 45° C above the ambient.

2.5.6 The main horizontal bus bars shall run through the entire length of the panel and shall be accessible for maintenance from the front. The bus bar chambers shall have separate covers.

2.5.7 All control and power fuses shall be link type HRC fuses.

2.5.8 All indicating instruments shall be of flush mounting industrial pattern, conforming to the relevant standard.

2.5.9 All control wiring shall be carried out with 1100/660 V grade single core PVC cable conforming to IS: 694 / IS 8130 having stranded copper conductors switchboard wires of size not less than 1.5 sq.mm.

2.5.10 All indoor / outdoor cable shall be rated for a voltage rating of 650/1100 Volts.

2.6.0 DIESEL ENGINE CONTROL PANEL

The Diesel Engine Starter panel shall be provided with a trickle cum boost battery charger and automatic starting of the diesel engine pump. Besides automatic mode, the pump shall be started manually also. The control panel is to be housed in a 16 SWG CRCS cabinet with powder coated painting in signal red.

The panel shall be provided with a lockable front door with a transparent acrylic front. Access to the operational level is to be achieved after opening the lockable door. The cable entry shall be from top for which a removable gland plate is to be provided with required number of 20 mm knockouts. The battery charger section shall comprise of a linear power supply circuit which, in the trickle mode allows around 300 Milliamp. Current in to the battery, while in the boost mode the current capacity is increased to around 5 Amps. All controls and indications shall be clearly inscribed for each of operation.

The following controls shall be incorporated in the panel.

- Power ON/OFF switch.
- Charger mode selector switch.
- Accept push button.
- Reset push button.
- Start push button.
- Stop push button.
- Test switch.

If the pressure drops in the pipeline, the signal is to be given to the impulse generation circuit, which shall give three automatic impulses of 5 seconds each at an interval of 10 seconds.

If the engine starts within the first or second impulse, the generation of the further impulses shall be automatically inhibited. On the other hand, if the engine does not start after 3 impulses, the 'ENGINE FAILED TO START' audio-visual alarm shall be generated and further impulses shall not be given to start the pump. In such an instance, the operator has to start the engine in manual mode.

2.7.0 EARTHING

All the equipment inside the pump house shall be earthed in accordance with the provisions of the relevant IS code of practice IS 3043 and IEE rules. Parts of all electrical equipment and machinery not intended to be alive shall have two separate and distinct earth connections each to conform to the stipulation of the Indian Electricity Rules. Apparatus rated 240V and below may have single earth connections. The armour of cables and all conduits for cables shall also be connected to the earthing mains.

2.8.0 PIPES AND FITTINGS

2.8.1 All pipes used in the fire protection system shall conform to the following:

- a. All above ground pipes used in the system shall be of MS ERW Galvanized pipes conforming to IS1239 (heavy grade).
- b. All underground pipes shall be Ductile Iron tyton joint pipes conforming to IS:8329.

2.8.2 All pipe fittings used in the fire protection system shall conform to as below:

- a. MS ERW (Galvanized) conforming to IS 1239 Part II up to 150 mm dia for above ground.
- b. Ductile iron all flanged fittings conforming to IS:9523 shall be used for under ground pipes.

2.8.3 All pipes and valves as shown in tender drawings as well as required for completion of the system with all fittings etc are included in the scope of supply of the tenderer.

2.8.4 All piping and fittings for vents, drains and valves are included in the scope of supply.

2.8.5 The entire pipe work within the pump house, between pump house to reservoir, pump house to all the building are included in the tenderer's scope of supply.

2.8.6 Underground MS galvanized piping where ever laid shall be wrapped and coated with anti-corrosive tape of 4mm thick conforming to IS: 10221.

2.8.7 The piping system and components shall be capable of withstanding 150 percent of the working pressure including water hammer effects. The piping shall be hydraulically tested to 150 percent more than the maximum working pressure after fabrication and erection for a period of 2 hours without any leaking in the sections. The drop pressure of 0.5Kg/Cm² shall be accepted in the system main due to environment conditions.

2.7 HYDRANTS

Fire hydrant valve shall be of single outlet SS construction with 80 mm dia flanged inlet and 63mm female instantaneous oblique outlet with blank cap and chain conforming to IS: 5290 type "A". All hydrant outlets shall be positioned towards the ground.

The hoses shall be of non-percolating flexible (RRL) hose conforming to IS:636. Hoses shall be of 63mm dia with SS couplings bound on both sides with copper wire. Hoses shall be factory-tested to a burst pressure of 36 bar.

2.8 BRANCH PIPES WITH NOZZLE

The branch pipe with nozzle shall be constructed from SS. The branch pipe shall have 63mm male coupling on one end and 15mm dia bore nozzle on the other side and shall conform to IS: 903.

2.9 HOSE HOUSES

Internal hose houses shall be constructed of brickwork with aluminum front glass door with necessary rubber bedding, universal key. The doors shall be painted with one coat of zinc rich primer and two coats of red enamel paint. External fire hose cabinets of size 900 mm x 600 mm x 350 mm shall be made out of 16 gauge sheet steel material with glass front door with necessary bedding, universal key, a pocket at one side to keep hose box key. The whole unit is painted with one coat of zinc chromate primer and two coats of synthetic enamel post office red paint. Inside of the box shall be painted with zinc chromate primer with two coats of synthetic enamel white paint.

2.10 BUTTERFLY VALVES

The butterfly valve shall conform to IS: 13095 and shall be of PN1.6 rating. The material construction of the various components shall be as follows:

- Body : Cast Iron
- Disk : SG Iron
- Seat : Black Nitrile
- Shaft : AISI 410
- Bearing : PTFE
- O ring : Nitrile
- Hand lever : SG Iron

The pressure rating of the butterfly valve shall be as follows

- Test pressure at Body : 24 Kg/Cm²
- Test pressure at Seat : 16 Kg/Cm²

2.11 SLUICE VALVES

All gate valves in the pump suction main and fire water tank outlet shall be of cast iron double flanged bolted bonnet non rising spindle inside screwed gate valves conforming to IS: 14846 and shall be of PN 1.6 rating. The material of construction of the various components shall be as follows:

- Body : Cast Iron
- Bonnet : Cast Iron

Wedge : Cast Iron
Stuffing Box : Cast Iron
Gland : Cast Iron
Hand Wheel : Cast Iron
Stem : HTB – IS: 320 HT 1
Body Seat Ring : LTB – IS: 318 Gr.2
Wedge Seat Ring : LTB – IS: 318 Gr.2
Wedge Nut : LTB – IS: 318 Gr.2
Gland Packing : Hemp Greased

The pressure rating of the gate valve shall be as follows

Test Pressure at Body : 24 Kg/Cm²

Test Pressure at Seat : 16 Kg/Cm²

2.12 NON- RETURN VALVES

All non-return valves in the pump delivery line shall be of wafer type Swing check valves. The material of construction of the various components of the valve shall be as under.

Body & Cover - Cast Iron

Disc & Hinges - SS

Hinge Pin - SS

The pressure rating of the non-return valve shall be as follows.

Test Pressure Body - 24 Kg/cm²

Test Pressure Seat - 16 Kg/cm²

2.13 PRESSURE GAUGES

The pressure gauge shall be of 0-16 kg/sq.cm rating with 100-mm dial. The body of the gauge shall be of pressed steel and dial and needle shall be of nonferrous material. Pressure gauge shall be filled with glycerin and it shall be provided with isolation valve.

2.14 PRESSURE SWITCHES

The pressure switch shall be diaphragm type and suitable for line pressure up to 12 kg/cm². The switch shall be suitable for consistent and repeat operation without change of values. It shall be provided with IP 55 weatherproof protection. The enclosure shall be Aluminium for elements and welded parts shall be of stainless steel. The switch shall be snap acting type with required number of NO/NC contacts.

2.15 FIRE BRIGADE INLET

The brigade inlet shall have cast iron body fitted with four gun metal 63 mm dia instantaneous male inlet conforming to IS 903 and a 25 mm dia drain valve. The gun metal inlets have in built non-return valves. The material of construction shall be:

Body - Cast Iron
Male inlet - Gun metal
Drain valve - Gun metal / Brass
Non return valve seat - Hardened rubber
Blank cap - Rubber

2.16 HOSE REEL

The hose reel drum shall be of fabricated mild steel construction, suitable for mounting, swinging type with inlet gate valve and painted in fire red finish. It shall accommodate 20 mm bore 36 Mtrs. long high pressure braided rubber water hose.

2.17 Pipe Fabrication & Erection

Underground piping shall be laid not less than one meter to the top of pipe below the ground level, suitable masonry supports, and concrete anchor blocks of suitable design shall be provided at every change in direction of pipeline both horizontal and vertical and near every pipe joints where soil conditions are unsatisfactory. Above ground piping shall be provided with welded joints only unless flanges are warranted. All fittings shall be heavy grade wrought or mild steel conforming to ASTM A234 Gr. WPB Sch. 40 (IS: 1239 Part II). The flanges shall be drilled as per IS: 6392 Table -17.

Flanges shall be faced and shall have insertion of neoprene rubber gasket. The joints shall be capable of withstanding a pressure of 10.5 Kg/Cm². All the above ground piping shall be supported by angle iron brackets on walls or suspended by hangers from ceiling or concrete pedestals at some places. Piping above ground shall be painted with two coats of approved enamel over a coat of zinc chromate primer after the installation and testing.

2.20 TESTING

After laying and jointing, the piping shall be pressure tested by hydrostatic method. The piping shall be slowly filled with water in order to expel all the air. The piping shall then be allowed to stand full of water for 24 hours. Any leakage at flanges or elsewhere shall be rectified. The pressure shall then be applied by means of a test pump (either hand or electric motor operated). The test pressure shall not be less than 1.5 times the working pressure of the system. All the leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the Owner/Architect /Consultant. The system shall also be tested for its desired performance and function by opening hydrant valves on each floor separately and four landing valves simultaneously. The flow of water at the top most hydrant shall be checked when three landing valves below are open. The cutting in and cutting out pressure setting of starting device shall also be checked for its correct operation.

The test results shall be recorded and countersigned by Owner's representatives and submitted in quadruplicate for approval by the Owner.

2.24 Commissioning:

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After testing the system at a test pressure the system shall be commissioned for operation for the purpose of fire fighting. Same procedure is to be illustrated to safety officer of client.

TECHNICAL DATA
(To be filled by the tenderer)

i. Main Electrical Fire Pump Set :

Sl.No	Description	Specification
1.	Make	
2.	Model	
3.	Type	
4.	Discharge capacity	
5.	Discharge head	
6.	Speed	
7.	BKW absorbed at rated capacity	
8.	BKW absorbed at 150% of discharge	
9.	Material of Construction	
	a. Casing	
	b. Impeller	
	c. Shaft	
	d. Shaft sleeves	
	e. Impeller wear ring	
10.	Prime mover kame	
11.	Prime mover rating	

ii. Electrical Jockey Pump set :

Sl.No	Description	Specification
1.	Make	
2.	Model	
3.	Type	
4.	Discharge capacity	
5.	Discharge head	
6.	Speed	
7.	BKW absorbed at rated capacity	
8.	Material of Construction	
	a. Casing	
	b. Impeller	
	c. Shaft	
	d. Shaft sleeves	
	e. Impeller wear ring	
9.	Prime mover kame	
10.	Prime mover rating	

iii. Main Diesel Engine Driven Fire Pump

Sl.No	Description	Specification
1.	Make	
2.	Model	

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3.	Type	
4.	Discharge capacity	
5.	Discharge head	
6.	Speed	
7.	BKW absorbed at rated capacity	
8.	BKW absorbed at 150% of discharge	
9.	Material of Construction	
	a. Casing	
	b. Impeller	
	c. Shaft	
	d. Shaft sleeves	
	e. Impeller wear ring	
10.	Prime mover name	
11.	Prime mover rating	

iv. Hydrant Valve :

Sl.No	Description	Specification
1.	Make	
2.	Material of construction	
3.	Size	
4.	IS standard	

v. RRL Hose

Sl.No	Description	Specification
1.	Make	
2.	Material of construction	
3.	Size	
4.	IS standard	

vi. Branch Pipe

Sl.No	Description	Specification
1.	Make	
2.	Material of construction	
3.	Size	
4.	IS standard	

vii. Butterfly Valves

Sl.No	Description	Specification
1.	Make	
2.	Material of construction	
	a. body	
	b. seat	
3.	Pressure rating	

B. FIRE DETECTION & ALARM SYSTEM

1.0 BASIS OF DESIGN

An intelligent Fire Alarm System (IFAS) shall be provided to effect total control over the life safety services required in the facility. The IFAS shall be of the digital, distributed processing, real time, multi-tasking, multi-user and multi-location type. IFAS shall be integrated to Building Automation System and Security System. Fire Alarm Main Panels shall be located in the Fire Alarm Room located in the reception. Repeater panel shall be located as per direction .of EIC.

2.0 APPROVALS

The system shall have proper listing and / or approval from the any one of the following nationally recognized agencies.

- ~ UL – Underwriters Laboratories Inc
- ~ ULC – Underwriters Laboratories Canada
- ~ FM – Factory Mutual
- ~ Vds
- ~ EN Standards

The Fire Alarm Control Panel, Detectors, devices, sounder, strobes etc., shall be above said approved authorities.

3.0 BRIEF DESCRIPTION OF FIRE ALARM PRODUCTS

3.1 FIRE ALARM CONTROL PANEL (FACP)

The distribution intelligent Fire Alarm Control Panel (FACP) shall function as fully stand-alone panel as well as providing a communication interface to the other fire alarm panel in other building. FACP shall have its own microprocessor, software and memory. In the event of failure of the FACP or communication breakdown between the other panel and the FACP, the FACP shall automatically operate on stand-alone mode without sacrifice any functions. The FACP shall be capable of accepting up to 5 fire loops with each loop capable of handling minimum 99 detectors and 99 modules.

FACP's shall supervise detection circuits and shall generate an alarm in case of abnormal condition. FACP's shall provide general purpose inputs for monitoring such functions as low battery or AC power failure. FACP's shall provide tamper protection and commendable outputs, which can operate relays or logic level devices. Output commands shall take any of, but not limited to, maintained command, Momentary Command, Alarm Follow, or Alarm latch as required. Any relay in the FACP which is intended to be removable shall be supervised against removal.

Smoke detectors shall be powered using the FACP-based smoke detection circuits.

FACP's shall provide for resetting smoke detectors, fault-isolation and sensor loop operation. It shall be possible to mix different fire devices within the same FACP to optimize field wiring.

FACPs shall provide indication for communication with the repeater panel and alarm/trouble conditions in each sensor loops.

FACPs shall provide monitoring and control of one floor or area or for multiple floors or areas. FACPs shall meet the following requirements to assure the integrity and reliability of the system.

FACP electronics shall be contained in an enclosure in a sheet metal enclosure. Access to FACP switches and electronics shall be by key – lock. Usage of no other tools should be required. Visual indicators of FSP status for each zone shall be visible without opening the key – locked cover.

All hardware and software to allow the FACP configuration and operation to be changed shall be provided. Memory data shall be contained in non-volatile memory (EPROM).

Alarm verification with field – adjustable time for individual smoke detector shall be provided. During the alarm verification, the panel shall retard the alarm until the end of the period. If the alarm is only a transient smoke alarm, the panel shall automatically reset the alarm. Only a verified alarm shall initiate the alarm sequence for the software zone (logical Point Group) or point. Final time setting shall be as per approval of the fire authorities.

Digital numeric display at the FACP shall be provided to indicate point in alarm or trouble. In such systems, means for manually scanning the points in trouble shall be provided and a trouble and alarm LED shall be used to indicate that there are points in alarm/trouble. The alarm/trouble LED shall only extinguish when all alarm /troubles are cleared from the loop.

It shall be possible to command test, reset and alarm silence from both the FACP and repeater panel.

FACP switches shall allow authorized personnel to accomplish the following,

- Initiate a general alarm condition.
- Silence the local audible alarm.

It shall be possible to acknowledge (Silence the local FACP audible) without silencing the alarm indicating devices (hooters).

Walk test.

Software zones / loops shall be circuited and protected by Fault Isolation modules which are provided along with all detector / devices.

Intelligent Smoke and thermal sensors shall be located as shown and shall report sensed levels in analog form. Monitor modules shall be provided to monitor and address contact - type input devices.

The FACP shall be able to set dual alarms threshold for occupied and unoccupied periods. During unoccupied the alarm threshold shall automatically be lowered to facilitate quicker. In addition, the FACP shall further process all analog values for pre-alarm limits to.

Any time sensor value transitions beyond the secondary and higher limit value, an alarm initiation and report shall be issued. Limits and sensor values shall be displayed, modifiable, and reported in decimal values.

The FACP shall have Drift Compensation facility to compensate for environment. The FACP shall have the ability to recalibrate. Pre- alarm and Alarm limits if required, after comparing each sensor's operating characteristics with the set sensitivity. This should annunciate trouble conditions when sensor(s) is beyond compensation range (excessively dirty sensor).

FACP shall have real – time clock to prevent loss of time and date in case of failure of power supplies.

The display on FACP shall provide indication for AC power, System Alarm, system Trouble/Security Alarm, Display Trouble and Signal Silence.

Minimum two different password levels will be provided to prevent unauthorized system control or programming.

Operator control switches for Signal Silence, lamp Test, Reset, System test and Acknowledge shall be provided.

The FACP should truly field programmable. This would mean that in the event of change of any logic, detector / zone sequence alteration, the operator can initiate these by use of the alpha-numeric keys on the FACP panel to reconfigure the above parameters. Panels, which require external programming devices to perform the above function, will not be acceptable.

Power supply unit of FACP shall have following characters:

The main power supply shall be 230 VAC $\pm 10\%$, 50Hz $\pm 1\%$ and shall in turn provide all necessary power of the FACP.

It shall provide a battery charge for 24 hours for standby power using dual-rate charging technique for fast battery recharge.

It shall provide a very low frequency sweep earth fault detect circuit, capable of detecting earth faults on sensitive addressable modules.

It shall be power-limiting using Positive Temperature Coefficient (PTC) resistor.

It shall provide indication for battery voltage and charging current.

For ease of service, all wiring terminal blocks shall be plug-in type and shall have sufficient capacity for 18 to 12 AWG wire termination. Fixed terminal blocks shall not be acceptable.

3.2 REPEATER PANEL

An repeater panel identical to the main control panel display shall be provided which is completely compatible with main panel. The panel shall have minimum 2x40 character backlit and alphanumeric display. The repeater panel shall get its supply from the main panel and should not need external power supply operation of alarm silence, manual evacuation and system reset buttons should initiate the appropriate on the control panel. The repeater and main panel should monitor each other fault conditions and any anomalies in either panel should cause the relevant fault LED to illuminate and the buzzer to sound in both the panels

3.3 GENERAL FEATURES COMMON TO ALL DETECTORS

Compatibility: All automatic fire detectors shall be interchangeable without requiring different mounting bases or alterations in the signal panel.

Each detector shall be capable of performing independent fire detection algorithms. The fire detection algorithm shall measure sensor signal dimensions, time patterns and combine different fire parameters to increase reliability and distinguish real fire conditions from unwanted deceptive nuisance alarms. Signal patterns that are not typical of fires shall be eliminated by digital filters. Devices not capable of combining different fire parameters or employing digital filters shall not be acceptable. Each detector shall have an integral microprocessor capable of making alarm decisions based on fire parameter information stored in the detector head. Distributed intelligence shall improve response time by decreasing the data flow between detector and Analog loop controller. Detectors not capable of making independent alarm decisions shall not be acceptable. Each detector microprocessor shall contain an environment compensation algorithm which identifies and sets ambient "Environmental Thresholds" approximately six times an hour. The microprocessor shall continually monitor the environmental impact of temperature, humidity, other contaminates as well as detector aging. The process shall employ digital compensation to adapt the detector to both 24 hour long term and 4 hour short term environmental changes. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 80% and 100% of the allowable environment compensation value. Differential sensing algorithms shall maintain a constant differential between selected detector sensitivity and the "Learned" base line sensitivity. The base line sensitivity information shall be updated and permanently stored at the detector approximately once hour. Systems in which the environmental compensation is done at the panels and not at detector levels shall not be accepted.

Built-in-response indicator: Each detector shall incorporate indicator "LED" at the detector which shall blink during normal condition and light up on actuation of the detector to locate the detector which is operated. The detector shall not be affected by the failure of the response indicator lamp.

Maintenance: All detectors shall be fitted either with plug-in system or bayonet type connections only from the maintenance and compatibility point of view.

3.3.1 Intelligent Addressable Photoelectric Smoke Detectors

Smoke detectors shall be microprocessor based, intelligent and addressable devices, and shall connect with two wires to one of the Fire Alarm Control Panel loops. Minimum of 99 intelligent detectors should connect to one loop. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density. The detectors shall be ceiling mounted type and shall include a twist-lock base.

The detectors shall provide addressable-setting. The detectors shall also store an internal identifying code, which the control panel shall use to identify the type of detector.

The detector shall provide dual alarm power LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel. Both LEDs may be placed into steady illumination by the control panel, indicating that an alarm conditions has been detected. An output connection shall also be provided in the base to connect an external; remote alarm LED.

3.3.2 Multi Criteria addressable smoke detector

Smoke detectors shall be microprocessor based, intelligent and addressable devices, and shall connect with two wires to one of the Fire Alarm Control Panel loops. Minimum of 99 intelligent detectors should connect to one loop. The detectors shall have dual sensors i.e photo diode to work photoelectric (light-scattering) principal to measure smoke density and thermal sensor to measure the atmospheric temperature changes.. The detectors shall be ceiling mounted type and shall include a twist-lock base.

The detectors shall provide addressable-setting. The detectors shall also store an internal identifying code, which the control panel shall use to identify the type of detector.

The detector shall provide dual alarm power LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel. Both LEDs may be placed into steady illumination by the control panel, indicating that an alarm conditions has been detected. An output connection shall also be provided in the base to connect an external; remote alarm LED.

3.3.3 Response Indicator

In addition to built-in response indicator of each detector, secondary response indicator of LED type shall be provided outside the room wherever asked for by the Consultant, for indication of fire through detector in the room.

3.3.4 Addressable Manual Stations

Addressable manual stations shall be provided to connect to the fire Alarm control panel loops.

It shall be possible to address each intelligent fire alarm pull station. Press/break stations with re-settable capability are also acceptable. The word FIRE shall appear on the front of the stations in raised letters.

Stations shall be suitable for surface mounting, or semi-flush mounting. And shall be installed not less than 42 inches, nor more than 48 inches above the finished floor unless otherwise specified by applicable building codes.

3.3.4 Addressable Sounders

All loop sounders should preferably be addressable and software configurable. All sounders should be able to provide at least a minimum of 3 different tones, which should be user configurable. The minimum decibel level of each hooter should be 80db.

3.3.5 Addressable Control Module / Relay Module / Monitor Module

The control module / Relay Module / Monitor Module shall provide address setting and shall also store an internal identifying code which the control panel shall use to identify the type of device. An LED shall be provide which shall flash under normal conditions, indicating that the control module is operational and is in regular communication with the control panel.

3.3.6 Cable

The cable shall be 2Cx1.5 sqmm, twisted shielded, FRLS type, armoured double insulated copper cable shall be used to connect all fire alarm detectors and devises with panel.

3.4 OTHER DEVICES:

Fault-isolation of fire zones (Logical Point Group) / circuit modules shall be provided, to enable part of a fault-tolerant loop to continue operating when a short circuit occurs in the loop.

SPECIFICATION TO BE FILLED BY TENDERER

Following data sheets to be filled and submitted by vender during the submission of tender. The data shall strictly meet the specification given above.

Fire Alarm Control Panel			
SL.No	Technical Specification	Supplier Specification	Equipment
1	Make		
2	Type		
3	Type of Display		
4	Power Supply		

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5	Battery back up	
6	Response time	
7	Intelligence Capability	
8	Addressable Capability	
9	Loop Capacity	
10	Maximum loop Length	
11	Fault Isolation Capability	
12	Alarm Verification	
13	Fire Pattern recognition	
14	Networking Capability	
15	Historical log	
16	Fault tolerant wiring capability	
17	Approvals/Listing	

Repeater Panel with display

SL.No	Technical Specification	Supplier Specification	Equipment
1	Make		
2	Type		
3	Display		
4	Voltage Requirement		
5	Distance Limitation		
6	No of Display Panels per system		
7	Programming of Display Panel		

Optical Smoke Detector

SL.No	Technical Specification	Supplier Specification	Equipment
1	Make		
2	Type		
3	LED Indication		
4	Blinking LED Facility		
5	Addressable Capability		
6	Intelligent Capability		

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7	Operating Voltage	
8	Alarm Current	
9	Approvals/Listing	
Heat detector		
SL.No	Technical Specification	Supplier Specification Equipment
1	Make	
2	Type	
3	LED Indication	
4	Blinking LED Facility	
5	Addressable Capability	
6	Intelligent Capability	
7	Fixed temperature alarm	
8	Rate of rise temperature	
9	Operating voltage	
10	Normal current	
11	Alarm Current	
12	Approvals/Listing	
Multi-Sensor		
SL.No	Technical Specification	Supplier Specification Equipment
1	Make	
2	Type	
3	LED Indication	
4	Blinking LED Facility	
5	Addressable Capability	
6	Intelligent Capability	
7	Fixed temperature alarm	
8	Operating voltage	
9	Normal current	
10	Alarm Current	
11	Approvals/Listing	

Manual Pull Station			
SL.No	Technical Specification	Supplier Specification	Equipment
1	Make		
2	Type		
3	LED Indication		
4	Operating Voltage		
5	Normal current		
6	Approvals/Listing		

Loop Sounder			
SL.No	Technical Specification	Supplier Specification	Equipment
1	Make		
2	Type		
3	Noise level (Distance coverage)		
4	Operating Voltage		
5	Approvals/Listing		

Fault Isolator Module			
SL.No	Technical Specification	Supplier Specification	Equipment
1	Make		
2	Type		
3	LED Indication		
4	Operating Voltage		
5	Normal current		
6	Approvals/Listing		

Monitor Module			
SL.No	Technical Specification	Supplier Specification	Equipment
1	Make		
2	Type		

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3	LED Indication	
4	Operating Voltage	
5	Normal current	
6	Approvals/Listing	
Control Module		
SL.No	Technical Specification	Supplier Specification Equipment
1	Make	
2	Type	
3	LED Indication	
4	Operating Voltage	
5	Normal current	
6	Approvals/Listing	
Cables For Fire Alarm System		
SL.No	Technical Specification	Supplier Specification Equipment
	FAS Signals	
A	Manufacturer	
C	No. of Cores	
D	Area	
E	Type	
G	Standards	
H	Application	

SECTION VI

SPECIFICATIONS AND CONDITIONS BUILDING MANAGEMENT SYSTEM

1.0 GENERAL

The work under this section consists of design, provision and Installation of Building automation for CONSTRUCTION OF Super Specialty Hospital for GOVERNMENT RAJAJI HOSPITAL AT MADURAI, TAMIL NADU.

The following systems interface are proposed to in BMS

2.0 AC PLANTS

AC plants will be monitored and controlled by BMS system. Chillers, pumps (Primary and Secondary) and valves (Chiller out let, Condenser out let and CT outlet) are activated based on run hours for optimization. Delta temperature (Difference between Return and supply temperature) will be considered as load to decide number of system to runs. Test mode has been provided to activate individual equipments directly form GUI.

Chiller Inlet / Outlet temperature, outside temperature and humidity are to be monitored and logged.

Alarm will be generated during abnormal condition like temperature out of range etc.

3.0 AIR HANDLING UNIT

BMS system will maintain Return Air Temperature by modulating CHW valve based on set point and control parameters. Algorithm for control logic will be PI. BMS system will maintain Return air Temperature & RH by modulating HW valve based on set point and control parameters. Algorithm for control logic will be Reverse PI.

AHU fan can be operated in schedule mode, Test mode and Manual Mode. In test mode AHU Fan can be operated directly from GUI. Supply Air temperatures, Room temperature & RH, Modulating Valve output and AHU Hours will be monitored and logged. Alarm will be generated during abnormal conditions like Fire status and Temperature and Relative Humidity out of range etc.

4.0 EXHAUST FANS

Exhaust fans will be operated by BMS system in schedule mode and test mode. Test mode can be operated directly from GUI. Running hours will be monitored and logged.

5.0 WATER MANAGEMENT SYSTEM

All pumps will be monitored in BMS. Sump high level and low level, Tank levels and pump runs hours will be monitored and logged. Pump runs status will also be monitored logged. Pumps can be operated in Schedule mode and Test mode.

All pumps ON / OFF status, flow monitoring, pump A/M status, pump trip status, Treated water sump level monitoring are all in the BMS. The same arrangement for STP, Raw water, pump compressor Recycle pumps clarified water pumps, reclaimed water pumps all ON/OFF and status will be monitored in BMS.

6.0 MV Panel Board

MV Panel Board will also be monitored in BMS. Breakers ON/OFF status, Earth Fault, over current alarm is all monitored in BMS.

The IO summary separately enclosed in self explanatory which will picture in details what the systems are proposed for monitoring and controlling in BMS. The Technical Specification of the system is enclosed which describes in detail about all the components proposed for BMS.

BUILDING AUTOMATION SYSTEM (BACS) SPECIFICATION

7.0 General

- 7.1 The Building Automation System (BACS) supplier shall furnish and install a fully integrated building automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, suitable for the building usage. The control strategies shall be developed to ensure that the specified environmental conditions are maintained, whilst giving due regard to minimizing of energy consumption.
- 7.2 The system design shall utilise the latest technology in “open” network architecture, distributive intelligence and processing, and direct digital control. The BACS system offered should be from the latest offerings and should be of freely programmable management and automation stations for the full spectrum of today’s building application services.
- 7.3 All peripheral equipment e.g. sensors, pressure switches, control valves and actuators, shall be of the same manufacture as the direct digital control modules and outstations.
- 7.4 The system offered shall be completely modular in structure and freely expandable at any stage from the smallest system through to large distributed

systems. Each level of the system shall operate independently of the next level up.

- 7.5 The system shall fully be consistent with the latest industry standards, operating on Windows 2000, Windows XP or later, allowing the user to make full use of the features provided with these operating systems.
- 7.6 To provide maximum flexibility and to respond to changes in the building use, the system offered shall support the use of BACnet/Lon, LONworks, and Profibus and Ethernet TCP/IP communication technologies.
- 7.7 The MEP contractor shall establish the number of equipment to be controlled / monitored by the BMS from the drawing/ schedule/ specifications. This information shall be furnished to the BMS supplier. All plant and equipment requiring control and / or monitoring functions shall be fitted with all necessary interfacing equipment readable by the BMS network. The MEP contractors shall co-ordinate and ensure that this equipment shall provide the required signals to the BMS.

8.0 Essential functions of system

The system comprises the supply, engineering, testing and commissioning of an integrated building management system by a specialist manufacturer.

The essential functions of the system are as follows:

- Centralised operation of the plant (remote control)
- Dynamic and Animated Graphic details of Plant and building
- Early recognition of faults
- Faults statistics for identification
- Trend register to identify discrepancies, energy consumption, etc.
- Preventive maintenance and plant servicing
- Optimum support of personnel
- Control optimisation of all connected electrical and mechanical plant
- Prevention of unauthorised or unwanted access
- Own error diagnosis integrated system

9.0 General System Architecture

9.1 The system shall be logically structured into three distinctive levels, which are Management Level, Automation Level, and Field Level. Each level shall be autonomous from the other. Peer to peer communication shall be possible on all system levels and the system design shall be modular in structure to allow straightforward extensions.

10.0 Use of communication standards

10.1 Only the following standards are appropriate to be used at the three levels.

- Management level - BACnet, Ethernet TCP/IP
- Automation level - BACnet on LonTalk,
- Field level - LonTalk with LonMark profiles

11.0 Management Level

11.1 The head-end management and operation of the plant shall include process visualization, data analysis, and exchange of data with 3rd parties. At the management level, it shall be possible for communication to flow in all directions, across networks and via direct connections.

11.2 Personal computer based operator management stations shall be provided for plant supervision and operation, alarm management, information and database management function. All real-time control functions shall be resident in the DDC controllers to facilitate greater fault tolerance and reliability.

11.3 The operator management station should be capable of multi-tasking 32-bit programs by utilising a Microsoft Windows XP operating system.

11.4 The management level of the system shall consist of one, and shall be capable of handling more management station PCs and the associated software modules.

11.5 The management station shall be capable of the following:

- Display of graphical representations of the plant overlaid with live data
 - High quality dynamic graphics with true multitasking of all active pages
 - Monitor and operate / influence process devices
 - Receiving of alarm messages from the process level and directing them to the appropriate reporting device e.g. printer, pager, fax, e-mail
 - Monitor process devices for communication problems and other device faults.
 - Alarm handling – all the alarms shall be displayed in a graphical tree structure in order located alarms quick and easily.
 - Adjusting time strategies in the process level.
 - Long term storage of logged data from the process devices
Multi level user access control for individual access to sites, applications, functions and objects
-
- Display graphically the logged data
 - Custom application programming

- Use of graphical genies to allow manipulation of data.
 - The user interface shall be based on a basic taskbar, which is always visible.
 - History logging for alarms, user actions, system events and messages
 - Alarm handling – all the alarms shall be displayed in a graphical tree structure in order located alarms quick and easily.
 - Simultaneous connection of at least of 4 sites via serial connections / 50 sites via IAN/WAN connections for a comprehensive overview on geographically distributed projects
- For maximum fault tolerance, the management stations connect to the process level via point-to-point communications. This shall be via RS232, Ethernet/TCP/IP LAN / WAN or via AutoDial links.
-

12.0 Automation Level

12.1 General Purpose controllers shall be used for monitoring / controlling equipment which have to perform based on a customized logic, such as AHUs, Chillers, Chilled water pumps, Cooling towers, Lifts, signals from Fire Alarm panels, generators, transformers etc.,.

12.2 At the heart of the DDC system shall be the Microprocessor based modules, which can be individually programmed according to the functional requirements.

12.3 The automation level DDC controllers shall monitor and control the main plant in the building. The DDC controller outstations shall be freely programmable and have the ability to perform all the following routines

- Process control & interlock functions.
- Generate alarms/events based on comparing measured values against know parameters.
- Time control strategies
- Runtime totalisation.
- Trend logging of specific data-points with transmission of the logged values to the management level
- Energy calculations
- Backup of the data/program (≥ 5 years)

12.4 The DDC controllers shall be selected from either a modular or compact type of unit to suit the most economic inclusion of all the data points specified. Each control module shall be capable of operating on a stand-alone basis without control from a central computer.

- 12.5** The input/output connection to Modular controllers shall be via individual plug-in modules suitable for the particular peripheral device. The digital modules shall have visual indication of the status of the input/output. Digital input modules shall be capable of accepting control voltages up to 230vac. **Modular controller should have hot swapping of I/O module.**
- 12.6 It shall be possible to integrate both types of control module onto the same BACnet communication network. Each controller performance shall be to 0.5% control accuracy with sample rates of less than one second.
- 12.7 Main plant DDC controllers shall be 32 bits freely programmable. All DDCs must be UL approved, must have an in-built real time clock and be suitable for PID control.
- 12.8 The products used in constructing the BMS management and automation levels shall conform to BACnet protocol for building automation and control networks. All controllers shall have attained a BACnet Testing Laboratories (BTL) listing
- 12.9 Room units shall utilize a two-wire communication link at each controller for the acquisition of room temperature and local set point. These will also provide an integral temperature/set point digital display. Up to 5 room units shall be able to use the same two-wire communication link
- 12.10 The system shall have the facility for a Web server to be added to allow full operation of all automation station control modules connected to the Lon Talk BACnet network via a standard thin client/web browser. Functions to include
- Display of graphical representations of the plant overlaid with live data
 - Data point display and operation of all measured values, set points, plant

States, operating states and parameters

- Alarm monitoring with acknowledgement and visual and audible alarm

Indication.

- Alarm and event history
- Alarm transmission via SMS and e-mail
- Operation of all time schedules, exception calendar and heating curves.
- Reading of trend data with facility to export data to Microsoft Excel.
- Multi user level access protection
- Ethernet or Modem connection

DDC Control Module Specification

The DDC controllers shall be selected from either a modular or compact type of unit to suit the most economic inclusion of all the data points specified. The

DDC controllers being used should confirm to the following specifications as a minimum:

Based on ANSI/ASHRAE standard 135-2001 (BACNet), ENV13321-1

- Operation standalone or as part of Lon Talk (clause 11) system network TP/FT-10, 78kBits with Built in BACnet/Lontalk interface or ETHERNET / IP
- Optional connection to operator terminal, management station and via Web browser with Web server device.
- Freely Programmable
- Flash ROM, real time processing and multi tasking
- 32 bit processor system, 1.5 MB program memory, No 8 bit or multiple of 8 bit
- Supply voltage AC 24V +/-20% 50/60 Hz
- Event driven data transmission
- Automatic mains recovery
- PPS2 connection
- Digital output to be 250V 2A rated changeover contacts
- Historical data memory storage
- Software application stored in non volatile memory
- Battery back up >= 5 Years

For the generation of the application programs, the following function elements are required as a minimum.

- Reset functions
- Set point jump
- Positioning time
- P-controller (reverse or direct acting)
- P1-controller (reverse or direct acting)
- PI-controller with I-deletion (reverse or direct acting)
- PID controller (reverse or direct acting)
- 2-point controller (reverse or direct acting)
- Proportional additional sequences (reverse or direct acting)
- Data transmitter (digital or analogue)
- Data converter (analogue-digital or digital-analogue)

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- Ring Counter
- Timer (switch on or switch off)
- Logic operations:
 - * logic "AND" (2,3 or 4)
 - * logic "OR" (2,3 or 4)
 - * logic "EXOR"
 - * logic "NOT"
- Comparative operations:
 - * Maximum values (2,3 or 4)
 - * Minimum values (2,3 or 4)
 - * Average values (2,3 or 4)
- Enthalpy calculation
- Optimiser
- Mean value calculation
- Hysteresis
- Output steps (digital or analogue)

Digital outputs shall be potential free outputs. Analog outputs shall be true analog outputs (0-10 V DC, 0-20 ma & 4-20 ma)

Above blocks shall be resident in the DDC Controllers and independent of any high level interfaces/controllers.

Further, the DDC unit software must have the following additional functions:

Free selection of range and unit (dimension) of all signals (measured values, accumulated values, calculated values, etc.)

Free allocation of access protection in accordance with operating priorities

Free definition of manual override priorities (software) from operator terminal and/or management station.

Wherever control logic is required for equipment such as AHUs, the DDC controller offered shall have a digital display on the fascia. This display shall be capable of displaying 2 categories of 3 parameters each. In the event of an alarm, the display shall switch over to an 'alarm' indication. In all, the controller shall have the capacity to indicate 8 different alarms. In case more than one alarm is active at

the same time, the controller shall display a coded alphabet, to alert that there is more than one alarm in the controller.

Each DDC Controller shall have a resident real time clock with a battery back up for a minimum of 4 years.

All DDC controllers shall be housed in IP 54 enclosures with proper termination of peripheral devices at the terminal strip and not directly to the controller.

13.0 Field Level

13.1 Individual terminal unit controllers for autonomous room – by – room comfort control, based on application specific logic written on the controllers. All the terminal unit controllers shall fulfill following general requirements:

- LONMARK communication
- AC230 V power supply
- Mountable with screws or DIN rail
- Optional terminal cover for local installation without cabinet
- Downloadable application software /adjustable parameter set, The type of Use shall be defined by downloadable pre-tested application software.

Common functions like grouping, scheduling, etc., shall be realised within a master controller on automation level.

All terminal unit controllers supplied on the project shall have the facility for local setpoint adjustment via a room unit.

Application specific controllers shall be used for terminal devices such as Fan Coil Units and the like. These controllers shall be with Lon Mark compatible bus communication. Any failure problem in communication bus should not affect the working of the FCU controller. A dedicated stand-alone controller shall be provided for each FCU. A common controller for FCUs serving different areas shall not be acceptable. These controllers shall be looped with a bus cable and connected to the BMS.

In general they shall comply with the following specifications

- ◆ For 2 or 4 pipe FCUs, with or without changeover
- ◆ PID control
- ◆ Downloadable application software over the BUS cable
- ◆ LonMark compatible bus communication
- ◆ To be integrated to the management station software
- ◆ Control of AC 24 V PWM valve actuators, 3 point AC 24 V valve and damper actuators, or electric heating coils
- ◆ Volt-free relays for fan control
- ◆ Operating Voltage → 230 V
- ◆ Internal fuse, thermal, automatic reset
- ◆ Connectable to 1 room unit via local bus, 2/4 wire unscreened twisted pair @ 4.8 KBPS

The application specific controllers shall be capable of working in conjunction with the following type of room controllers. The specific type of room controller to be used in specific applications shall be selected from any one of the following types to meet the description written in the sequence of operation.

TYPE 1

- ◆ Integrated room temperature sensor

TYPE 2

- ◆ Integrated room temperature sensor
- ◆ Dial for temperature set point

TYPE 3

- ◆ Integrated room temperature sensor
- ◆ Dial for temperature set point
- ◆ Rocker switch for off/auto¹ mode (single speed fan)

TYPE 4

- ◆ Integrated room temperature sensor
- ◆ Dial for temperature set point
- ◆ Rocker switch for off/auto¹ mode and fan speeds (3 speed fan)

TYPE 5

- ◆ Integrated room temperature sensor
- ◆ Dial for temperature set point
- ◆ Rocker switch for off/auto¹ mode and fan speeds (3 speed fan)
- ◆ LCD display of measured temperature

TYPE 6

- ◆ Integrated room temperature sensor
 - ◆ Rocker switch for temperature set point (raise/lower)
 - ◆ Rocker switch for off/auto¹ mode and fan speeds
 - ◆ LCD display of measured temperature
 - ◆ Communication with controllers via Lon bus
 - ◆ Exchangeable rocker switches for lighting and blinds
 - ◆ Selection of downloadable software applications for the operation of lighting and blinds
- Operating mode 'auto' –comfort, 'off' – standby or economy

FCUs FOR TYPICAL OFFICE/ROOM

Each FCU control shall consist of a dedicated controller mounted near the FCU above the false ceiling, a room unit with inbuilt temperature sensor, set point adjuster and 3-speed/OFF switch.

The FCU thermostat shall operate the modulating valve to meet the desired temperature condition. The FCU thermostat shall be connected to the BMS to enable temperature set point override etc. Via Modbus RS485 interface

14.0 Networks & File Servers

- 14.1** Wherever the building configuration supports in - built network cables, the system shall be able to accommodate several PCs hooked up at locations designated by the user at a later date. The management station software shall support the two leading network systems, Windows 2003 server.
- 14.2** The management station(s) shall be set up on the network in two different ways, either operating independently or as client management stations in conjunction with an (optional) file server.

14.3 To facilitate central storage of data and programs, the file server is envisaged. Central management of user-specific information such as passwords and protected access to data and programs shall thus be made easily possible. The file server shall also support software updates and changes in the project data. The file server shall also support consistent central archiving of alarms, off-line trend data, log data, graphics, data backup etc.

15.0 Printing

15.1 It shall be possible to connect printers either directly to the management station or to the file server.

16.0 Remote Monitoring and Control

16.1 It shall be possible, with additional hardware if necessary, to interrogate the system remotely via the following possible methods:

- Telephone connection
- Building IT network
- Web browser technology with password access via IT networks accessing information stored on dedicated embedded web server device installed on automation controller network.
- Alarm reporting to mobile pagers/phones/e-mail etc
- Energy usage monitoring and control via Building Management Systems.

17.0 BMS – Records

17.1 General

The details of the building automatic system shall include all the manufacturers Technical Data Sheets and User Manuals. Control valve schedules shall be provided the flow rates; valve pressure drop and system design basis on which the particular valve type was selected.

17.2 DDC Control System Software Strategies

Controller strategies shall be provided, in both hard copy and on CD-ROM, for inclusion in the Operating & Maintenance Manuals.

Copies of all the preliminary strategies, in both hard copy and on CD-ROM, shall be supplied to the Engineer prior to commencement of control systems commissioning.

Copies of all the 'As Installed' strategies, in both hard copy and on CD-ROM, shall be supplied to the Engineer within three months of hand over of control systems.

17.3 BMS Software and Licences

All Licence rights to the control systems manufacturers' software packages shall be transferred to the client at the time of hand over. User Registration must be made on behalf of the client, direct to the control system manufacturer by the specialist System House Partner.

Copies of all of the control system manufacturers Monitoring or BMS software shall be provided on CD-ROM, or other mass storage device, together with copies of any graphics and databases that may be required to re-install the system after a fatal computer failure.

17.4 Integration of secondary systems

Integrations shall be carried out at the most appropriate level within a system, depending on the functions and interaction required. The following integrations must be possible.

- Lon Works
- Lon Mark
- BACNet /LonWorks
- BACNet/IP
- OPC
- Integration of standard proprietary buses : Modbus, M Bus, KNX.

As part of the requirements for an open system devices with a Native BACnet protocol shall be connected onto a common field bus backbone network directly without any Gateway/Protocol converter device. If interaction is required between different sub-systems, the integration shall be carried out at either the automation or field level. The integration must not occur at the management level. Link to a third party software package such as a Planned Preventive Maintenance package or a Energy Monitoring package shall be carried out at the management level. When sharing alarm and historical information with Maintenance Management and Energy Management packages, the management system shall provide the information in a standard commercially available format e.g. MS Access and using standard mechanisms e.g. ODBC .Real-time "live" information shall be transferred form the management system to a third party package e.g. MS Excel, either by a standard inter-application

mechanism e.g. DDE or OPC or by developing a connection by using a documented API for the management system. Where a physical connection is required between a 3rd party device and the management system, the sub-system supplier shall provide the necessary line drivers and cables, documentation and support to make the connection into the device that will provide the protocol conversion.

18.0 Software Modules

18.1 The management station software shall be modular, object oriented, clearly structured and shall be based on Windows 2000 and Windows XP (or later) standard 32 bit technology.

The main software applications shall, as a minimum, include

- ◆ Plant Viewer : Graphics based operation of the plant
- ◆ Trend Viewer : Logging and display of measured values
- ◆ Alarm Viewer : Display of alarm messages
- ◆ Alarm Router : Automatic routing of alarms
- ◆ Log Viewer : Logging of alarms, system events and user activities

The Task Bar

The task bar shall be the 1st and last point of contact for all the interactions between user and system.

In addition to obtaining quick overview of vital system information, users shall be able to click on various icons in the task bar to switch from one program to another in the multi-tasking operating system. In systems, which include remote sites, the task bar shall be used to switch between sites (subject to user's access privileges).

To make the system easier for new users, the system shall support user-specific start-sequences with access to selected programs.

Features Of The Task Bar

- ◆ Control of access privileges and security mechanisms for access to program modules and 3rd part software at log-in and log-out.
- ◆ User-and-password dependent access to systems and sub-systems
- ◆ Automatic user-specific start sequences

- ◆ Display of alarm and system message status, site connection status, time and date
- ◆ Facility to connect and terminate connection at various sites
- ◆ Simultaneous connection to a maximum of 4 sites

Plant Viewer

The plant viewer shall support the following features

- ◆ Hierarchically linked, animated high-resolution bit-map colour graphics (XGA 1024 x 768 pixels)
- ◆ Choice of 2D and 3D symbols with animation based on status
- ◆ Direct access to set points, parameters, operating modes , alarms, time-programs, on- line and off-line trend data features
- ◆ Dynamic multi-tasking with all active pages
- ◆ Monitoring and operation of plant at several levels
 - ◆ Flexible operation of multiple pages using plant viewer navigation bar combined with standard handling of windows
- ◆ Navigation to all other management station software applications
- ◆ User-definable page size
- ◆ Jump tags for jumps on the same level or between levels
- ◆ ToolTips for all dynamic objects, with the option of 'User', 'Technical' or 'System' information
- ◆ Context-specific information (eg. data sheets) can be attached to any dynamic object
- ◆ Capable of graphics to be printed in colour or monochrome
- ◆ All 32 bit graphic file formats supported by Windows can be imported (eg → AutoCAD, PCX etc.,)
- ◆ Dynamic display of the Psychrometric chart, enabling easy simulation of the air – Conditioning processes.

Alarms Handling & Alarm Viewer

As a minimum, the system shall support the following features

- ◆ Operation and manipulation of alarms (based on user privileges)

- ◆ Alarm message printing
- ◆ Alarms printed independently of the management station (direct connection at automation level)
- ◆ Automatic pop-up windows for immediate display and operation of alarms (including Pop-ups in 3rd party programs)
- ◆ Audible or multi-media alarm indication
- ◆ Continuous overview of all active alarms from site (updated automatically, displayed in order of priority, option of personalized view)
- ◆ Graphics based topological view of alarms
- ◆ Chronological alarm view
- ◆ Option of displaying detailed information
- ◆ Direct access to associated plant graphics
- ◆ Comprehensive filter and search criteria (time, date, priority, discipline, alarm status etc.,)
- ◆ Colour coding based on alarm priority / alarm status (screen and printer)
- ◆ Alarms for out of limit values (high, low), change of state, run-time limits exceeded etc.,
- ◆ Option of repeating unacknowledged alarms at regular intervals
- ◆ Creation of reports, with facility to print or export alarm data to 3rd party programs for further analysis
- ◆ Facility to save user-defined filter criteria
- ◆ User-specific configuration of the alarm view including on-line configuration

Alarm Routing

In order to monitor alarms round – the – clock, alarm routing is an important feature of the BMS. The BMS shall have the following features

- ◆ Routing of alarms to alarm printer, fax, pager or mobile phone
- ◆ Time schedule for each message recipient
- ◆ Alarm routing based on priority
- ◆ Alarm routing based on discipline (HVAC, Security etc.,)
- ◆ Alarms routing to person responsible at site
- ◆ Alarm routing based on text

- ◆ Alarm routing to person(s) responsible for specific equipment or systems
- ◆ Option of manual transmission of messages from the management system

Time Scheduling

The time-scheduler shall have the following features

- ◆ 7 day time programs
- ◆ Exception programs (local, building-wise or system-wise)
- ◆ Direct display of time programs within Plant viewer graphics
- ◆ Simple graphics programming of switch times
- ◆ Graphics based overview of all time programs in the system
- ◆ Graphics based overview of a 7 day programme including all exception programmes
- ◆ Graphics based overview of all plant points affected by a time programme
- ◆ Direct entry of various operating modes (comfort, stand-by, energy hold-off)
- ◆ Easy creation, modification and deletion of all time programmes
- ◆ Scroll features for fast access to specific weeks or days
- ◆ Storage and processing independent of management station
- ◆ Automatic synchronization of all time programmes in a system
- ◆ Support of different time zones (remote managed sites)
- ◆ Option of synchronization via radio clock
- ◆ Printed reports in various display forms

Trend Viewer

The Trend Viewer shall have the following features

- ◆ On-line or off-line real-time data
- ◆ Simultaneous display of up to ten signals per window
- ◆ Absolute or relative time intervals
- ◆ Zoom, scroll and cursor features for faster data analysis
- ◆ Flexible, easy-to-use scaling feature with charts displayed in 2D or 3D
- ◆ Drag-and-drop feature for trend views with automatic scaling and data export
- ◆ Off-line data logging triggered manually, automatically, or on a time or event basis

- ◆ Logging and intermediate storage of off-line trend data operates independently of the management
- ◆ Automatic upload from automation level to local or remote management stations
- ◆ Management station display and archiving of on-line and off-line trend data
- ◆ Print-outs of trend data
- ◆ Easy export of data to 3rd party software
- ◆ Facility to export trend data directly to auxiliary programs such as ADP (Advanced Data Processing) or to 3rd party software such as MS-Excel
- ◆ Trend Viewer time base can be used directly as a filter creation in Log Viewer

Log Viewer

The Log Viewer shall be categorized into the following sections

ALARM LOG → contains all incoming alarms in chronological order

SYSTEM LOG → shows at a glance if a printer somewhere in the system has run out of paper, or a hard disk is full. Communication events are also recorded here, showing for example when communication was established or terminated

USER LOG → lists all the activities carried out by the user at the management station, unauthorized attempts, modification of parameters, set points etc.,

STATUS LOG → to check the status of all incoming messages

The Log Viewer shall have the following features

- ◆ Storage of alarms routed to the management station
- ◆ Storage of all system messages (from printer, communications, management station, modem etc.,)
- ◆ Storage of all user activities performed at the management station
- ◆ Facility to enter and store user comments on events and activities
- ◆ Facility to display, at a keystroke, detailed information on every entry
- ◆ Extensive filter options to focus and reduce the volume of information displayed
- ◆ Comprehensive search features for fast access to information
- ◆ Facility to display an overview of data for a given day or week

- ◆ Once defined, filter and search criteria can be saved for future re-use
- ◆ Compact archiving of virtually un-limited number of entries (depending on hard-disk capacity)
 - ◆ Automatic data management and archiving functions
 - ◆ Facility to create and print log summaries
 - ◆ Export of log entries for further analysis with 3rd party software (eg –MS access)
 - ◆ User specific configuration of log view can be adapted directly on line

Internet Log Viewer

This is an optional application, which offers users even greater freedom in the management of a site. A browser such as Microsoft Internet Explorer or Netscape Navigator, for example, provides the user with access to the log database from any PC with an Internet connection. Just as with standard log viewer, the user can then obtain an overall view of all the plant and events stored or monitored by the system.

The Internet Log Viewer shall be started without any special management station software on the user's PC. Access to the Log Viewer can be password protected.

A Web Control

The system shall have the capability to connect to remote sites through a web control module. Individual DDC general purpose communication trunks (described elsewhere) shall have the feature to be connected to this web control module. This should facilitate viewing and controlling the DDC general-purpose controllers trunk via a remote PC / laptop. All parameters as appearing in the Portable Operator Terminal (described elsewhere) shall be available from this remote PC / laptop. The system offered shall have the facility to control / monitor the plant and equipment connected to these communication trunks via password protection.

Integration of 3rd Part Software And Exchange Of Data

The system shall support the use of standard interfaces and drivers that make it easy to integrate to 3rd party software directly at the management station level, or to make common use of data from the system, eg via ODBC (Open Database Connectivity). DDE (Dynamic Data Exchange) shall enable current

data to be loaded continuously into a spreadsheet program such as MS Excel, so that constantly updated graphs can be created for further processing.

Object Viewer

To make operations easier, the software shall have two viewing modes.

System View → Provides hierarchical view of the system network.

User Designation View → Gives a hierarchical breakdown of user addresses based on the system database.

In general, the system shall support the following features

- ◆ Fast navigation through the system
- ◆ Fast location of objects and alarms
- ◆ Detailed information of all objects
- ◆ Display of current values from throw process level
- ◆ Modification of set points and parameters
- ◆ Users with appropriate access levels can also override outputs manually
- ◆ Two display modes → system view and user designation view
- ◆ Search features
- ◆ Jump features and bookmark features as in various internet browsers
- ◆ Modification of users designation and alarms texts
- ◆ Customization of users addresses with a maximum of 10 hierarchical levels and up to 40 characters
- ◆ “Find” function to locate system objects

Reports

Reports shall provide the user with the latest information from the system at specific times or when specific events occur. The following features shall be supported

- ◆ Reports routed on basis of time and / or priority
- ◆ Manual or automatic triggering
- ◆ User-definable or standard reports
- ◆ Facility to integrate 3rd party report programs into the management station software

Access Protection

The management station shall grant access to the system only to authorized users. The system administrator shall tailor an environment to match the individual requirements of each user. The access protection facility shall define the buildings (sites) and equipment to which a given user has access, the software modules and functions available to that user within the site. The system shall support the following features

- ◆ User name / password
- ◆ Individual access privileges covering access to sites, subsystems, program functions down to individual objects in Plant Viewer
- ◆ Up to 1000 users grouped into 100 user groups
- ◆ Automatic log – out (after period of inactivity)
- ◆ Encrypted passwords
- ◆ Network security provided by Windows

19.0 Hardware Requirements

DESKTOP COMPUTER

Processor	: Pentium Duo, 2.8 GHz
RAM	: 2GB
Hard Disk	: 500GB
Graphics card	: 1280 x 1024 (XGA), > 2 MB memory
Monitor	: 22"
Printer	: 132 column, dot matrix, black & white
CD drive, multimedia kit, modem card	

20.0 BACnet Routers

In addition to exchanging data with the management station and the other Controllers in the same network, a further capability of transferring global data between DDC modules in different groups (i.e. on different buses).

The BMS offered must be capable of being extended with controllers on the BACnet protocol and the LON bus.

The BMS must allow integrating future BACnet controllers on the process level and providing inter-process communication with existing controllers.

The BMS must allow to be extended with controllers on the BACnet protocol and the LON Talk technology.

The BMS must allow for integration of BACnet devices on the process level via LON bus and on the management level via Ethernet TCP/IP.

21.0 DDC LON network

This network shall allow the DDC modules to communicate with each other and provides the user with access via the operator terminal to all the connected DDC controllers.

The DDC controllers, wherever used, within the same enclosure, should be connected to each other via twisted bus cable and it should have the DATA network cable between distant controllers.

Upto 30 DDC modules, and a maximum of 15 operator terminals may be connected to one DDC LON network.

Data must be kept even in the event of power failure. Power failures and peak loads must not cause data loss.

Permanent self-monitoring of the system must be ensured by integrated test and service functions.

Suitable interfaces and appropriate in/outputs must allow the integration of all electrical and mechanical plants.

22.0 Central setting of parameters/structuring and programming

It must be possible to enter and/or amend all parameters (set points, control algorithms, time, etc.) and the structure diagrams (control and interlock programs) into the lower levels system controllers and DDC units-centrally from the management station and/or the operator terminal from the system controller with a download function. The system manager must be able to read and write all data centrally.

It must be possible to set the parameters and structure the application programs by using a graphic and element oriented programming language.

23.0 Portable Operator Terminal (Pot)

Each DDC Controller shall have a dedicated service port to plug in the portable operator's terminal (POT). It shall be possible to read, write and change any parameters on a bus by plugging the POT to any one of the Controllers on the communication trunk. The portable operator's terminal shall have a visual and audible alarm with mute facility on its fascia. The POT shall have minimum three password levels. Separate cabling for connecting the POT shall not be acceptable. Changing the parameters locally from any Outstation shall be done by POT which is truly portable and hand held and not via Laptops.

A local operator terminal shall allow full operation of all DDC control modules connected to the LonTalk BACnet network. Functions to include

- Alarm monitoring with acknowledgement and visual and audible alarm indication.
- Pop up window with detailed message for alarms and events
- Alarm and event history
- Data point display and operation of all measured values, setpoints, plant states, operating states and parameters
- Graphic based display and operation of all time schedules, exception calendar, online trending and heating curve.
- User specific configurable overview of main values in plant
- Multi user level access protection

The operator terminal shall have a high resolution six line illuminated display for graphics and text, keys for operation and a visual and audible common alarm indication. The textual information displayed must reflect the layout of building and plant with clear text English descriptions of up to 40 characters

24.0 Documentation

In order to have clear system documentation, the following documents have to be provided:

- ◆ System diagram
- ◆ Wiring diagram
- ◆ Lists of parameters

For hand-over all documents must be up to date and provided with the date.

25.0 Services

The type and scope of the required services are described below.

The rates for engineering, commissioning and adjustment must contain all services required to ensure optimum operation of the plants.

26.0 Engineering/Planning

In addition to the required, complete documentation, the service must include:

- ◆ analysis of all functions together with the contractor
- ◆ binding information about conditions of connection of equipment
- ◆ scheduling and co-ordination with the contractor and design engineer

27.0 Commissioning/Adjustment

Function-oriented commissioning includes the following services, which are to be provided by BMS specialist:

- ◆ verification of the external connections of the equipment
- ◆ verification of the data transfer channels of the system
- ◆ loading and testing of all basic and user programs belonging to the equipment
- ◆ optimisation of the control parameters

28.0 Electric & Electronic Related Equipments

Ambient Conditions

All controls shall be capable of operating in ambient conditions varying between 0-40°C and 90% RH non-condensing.

Conduit Entry

All control devices shall, unless provided with a flying lead, have a 20 mm conduit knockout. Alternatively, they shall be supplied with adapters for 20 mm conduit.

Ancillary Items

When items of equipment are installed in the situations listed below the BMS/Control Specialist shall include the following ancillary items:

Weather Protection

All devices, which are exposed to the atmosphere, are to be weatherproofed. All controls, peripherals and associated accessories serving Chillers, Roof Mounted Air Handling Units and other equipment which are exposed shall be protected from Dust, Rain and Solar Radiation. Adequate protection shades etc., shall be provided by the MEP contractor

Pipe work Immersion

Corrosion resisting pockets of a length suitable for the complete active length of the device, screwed 1/2" or 3/4" BSPT suitable for the temperature, pressure and medium.

Duct Mounting (Metal or Builders Work)

Mounting flanges, clamping bushes, couplings, lock nuts, gaskets, brackets, sealing glands and any special fittings necessitated by the device, shall be provided by the MEP contractor.

Samples

Samples of all types of room mounted equipment (i.e. detectors, thermostats, etc.) shall be provided by the BMS/Controls Specialist for approval by the Consultant/Engineer.

Accuracy

Control and measuring devices shall have the following limits of accuracy:

Temperature	:	+/- 1°C over the range of 0°C to 50°C
Pressure	:	+/- 1.5% of measured value
Humidity	:	+/- 5% r.h over the range of 10 to 90% r.h

29.0 Averaging Elements

Averaging elements shall be used on supply air ducts having a cross-sectional area exceeding 1.6m² and shall have a minimum capillary length of 8.2 m.

The capillary element shall be serpentine across the whole duct.

Where the span of the element is less than 1 m then it shall be fixed with purpose-made clips and may be unsupported across the duct.

Where the span of the element is above 1 m then it should be supported on Unistrut or similar rigid support. The element shall be clipped every 200m and the supports and hangers shall be adequate to prevent vibration of the element.

30.0 Pressure switches for Air Systems

Pressure switches for Air Systems shall be diaphragm operated. Switches shall be supplied with air connections permitting their use as static or differential pressure switches.

The switch shall be of differential pressure type complete with connecting tube and metal bends for connections to the duct. The housing shall be IP54 rated. The pressure switches shall be available in minimum of 3 ranges suitable for applications like Airflow proving, dirty filter, etc. The set point shall be concealed type. The contact shall be SPDT type with 250 VAC, 1A rating.

Shall be supplied suitable for wall mounting or mounting on ducts in any plane. It should be mounted in such a way so that the condensation flow out of the sensing tips. Proper adapter shall be provided for the cables.

The set point shall fall within 40%-70% of the scale range.

Shall have differentials adjustable over 10%-30% of the scale range.

31.0 Air flow Switches

The Airflow switches shall be selected for the correct air velocity, duct size and mounting altitude.

Where special atmospheric conditions are detailed in the Motor Control Panel Equipment Schedules, the parts of the switches shall be suitably coated or made to withstand such conditions. Any variations from standard shall be detailed in the Tender.

Shall be suitable for mounting in any plane.

32.0 Water flow switches

Water flow switches shall be selected for the correct water velocity and pipe size and mounting attitude.

33.0 Room Temperature/Humidity Detectors

The temperature sensor shall have sensitivities such that a change at the detector of 0.2°C from the stabilised condition is sufficient to start modulating the corrective element.

The temperature sensor shall be with silicon sensor having positive temperature coefficient. The sensor shall be fielded wired using an unscreened cable to a base plate. The sensor housing shall plug into the base so that the same can be easily removed without disturbing the wiring connections. The protection standard shall be IP30 in accordance with IEC 144, DIN 40050. These should be generally mounted 1.5 m above the floor level. These should not be mounted near the heat sources such as windows, electrical appliances, etc. The final location shall be as per the consulting engineers' approval. The sensor shall be linear over 0°C to 50°C.

Shall operate on extra-low voltage and be suitable for mounting on British Standard conduit boxes.

The humidity sensor shall be in an independent housing or be combined with the room/duct type temperature sensor in the common housing. The sensor should be electronic type with capacitive sensing element. As a minimum it should have a range of 10 to 90% RH.

34.0 Immersion/temperature detector and duct mounted temperature/humidity detectors

The temperature sensor shall have sensitivities such that changes at the detector, for 0.3°C and 0.2°C respectively, from the stabilised conditions, are sufficient to start modulating the corrective element.

The humidity sensor shall be in an independent housing or be combined with the room/duct type temperature sensor in the common housing. The sensor should be electronic type with capacitive sensing element. As a minimum should have a range of 10 to 90% RH.

The temperature sensor shall be with silicon sensor having Positive Temperature Coefficient. The sensor shall be fielded wired using an unscreened cable to a base plate. The sensor housing shall plug into the base so that the same can be easily removed without disturbing the wiring connections. The protection standard shall be IP42 in accordance with IEC 144, DIN 40050.

The wiring terminals shall be plug-in type for easy installation and maintenance. The sensor shall be mounted in the duct based on the guidelines given by the specialist control supplier. The sensor shall be linear over 0°C to 50°C.

35.0 Pressure Detectors (for liquids and gaseous media)

Pressure detectors shall be suitable for the suitable for the medium and the working temperatures and pressures. The pressure detector shall be capable of withstanding a hydraulic test pressure of 2 times the working pressure.

Connections shall be suitable for 1/2 to 1/8th in o.d. copper tube.

Ductwork versions shall be supplied with the air connections permitting their use as static or differential pressure detectors.

The set point shall fall within 40%-70% of the sensing range of the detector.

The detector shall have sensitivity such that a change of 1.5% from the stabilised condition shall cause modulation of the corrective element.

The static pressure sensor shall be rated for IP65 and the differential pressure sensor shall be as a minimum IP54.

The principle of operation should be based on a hall-effect transducer. The diaphragm should be copper benylium type.

The sensor must be pressure compensated for a medium temperature of -10 to 80°C with ambient ranging between -25 to 60°C.

36.0 Air Pressure sensor:

The pressure sensor shall be differential type. The construction shall be spring loaded diaphragm type. The movement of the membrane in relation to the pressure should be converted by an inductive coupling, which would electromagnetically give an output suitable for the controller. The pressure sensor shall in a housing having IP42. Suitable mounting arrangement shall be available on the sensor. The sensor shall come complete with the PVC tubes, probes, etc.

37.0 Actuators

Shall be installed in accordance with the manufacturers' recommendations.

Shall have a sufficient torque to open and close valves and dampers against the maximum out of balance pressure across them.

Control Damper Actuators

Control Damper Actuators shall be of the type where the damper spindle passes through the actuator and is secured by a U clamp.

Rotary type damper actuators shall be used on the project. The actuators shall not require any maintenance. The actuators shall have sufficient torque ratings to operate the dampers of various sizes.

These should be available in spring return versions as specified elsewhere in the document. Limit switches, if required/specified shall be provided for.

The actuators shall be suitable for On/Off and modulating operations.

Actuator Additional features

Actuator Additional features are required when detailed in the Motor Control Panel Equipment Schedules or the Performance Section of the Specification.

Auxiliary Switches:

For On/off applications, the actuators shall have changeover contacts suitable for 220 VAC. 2 amp rating.

Auxiliary switch packs containing at least one, if specified two, electrically independent switches one for each end of the motor travel, adjustable for operation over at least half the motor travel.

Feedback signal

0 to 10 V dc. Signal should be available from the modulating damper actuator for parallel operation or as feedback. Please refer the data point schedules / sequence of operation/ drawings to incorporate this feature wherever asked for.

38.0 CONTROL VALVES (MODULATING)

General

All control Valves with Kv lesser than or equal to 4 shall have RG5 gunmetal / red bronze body. Actuators shall be PWM or 0-10v dc modulating motor type or 3 point reversible motor type. PWM actuators shall be used in conjunction with controllers having in-built PID algorithm.

Control Valves with Kv = 6.3 shall have RG5 gunmetal / red bronze body. Actuators shall be 3 point reversible motor type or 0 – 10 V dc modulating motor type. Actuators shall have manual override hand-wheel.

Control valves with $K_v > 6.3$ shall have RG5 gunmetal / CI. Actuators shall be magnetic / or 0 – 10 V dc modulating motor type. Actuators shall have manual override hand-wheel.

Valves up to including 40 mm shall be rated for 16 bar Nominal Pressure. Valves for 50 mm and above shall be rated for nominal pressure of 10 bar, provided the operating pressure of the system is not greater than 6 bar. Valves above 100 mm shall be rated for 16 bar Nominal Pressure and actuators shall for these valves be magnetic / electro-hydraulic / motoric working a 0-10v DC modulating signal. Actuators for valves 100 mm dia and above shall have spring return feature as well as manual override hand-wheel.

All valves 15mm and above shall have rangeability > 100 .

Authority

All 3 port modulating valves shall be selected to have an authority between 0.4 and 0.68.

For systems using 2 port modulating valves, the MEP contractor shall furnish the controls' supplier details such as Pressure drop across the index circuit based on which the pump head was calculated, the pump head calculation, the design head of the pump ordered for the project, the available pressure on the system and the nodal pressures on each branch circuit of each AHU / FCU.

Based on these data, the controls' supplier shall submit the working principle for valve selection.

Butterfly valves

Butterfly valves shall be manufactured by the Controls Manufacturer or alternative, approved by the Consultant / Engineer.

39.0 Occupancy detector:

The occupancy detector should be microprocessor based passive infrared detector for control of lighting equipment and VAV boxes in the room. The detector shall operate at 230VAC and will give a potential free output of minimum rating of 2 amps at 230VAC for control of lighting and VAV boxes for maximum energy savings and demand dependant controls. It should have a adjustable switch on delay of minimum 0...300 sec and a adjustable switch off

delay of minimum 0.5...30 minutes. The detector should cover a minimum zone of 6 X 12 meters. The detector should be capable of detecting a moving infrared source. It should be optimized to detect the low level of sedentary workers. The detector should have minimum sensitivity of 50cm physical movements. The detector should be minimum IP50 with CE conformance.

40.0 BTU meters:

The flow meter used in the above meter should be based on the ultrasonic principle with no moving parts. The temperature sensors used in the above meter should have a measuring range of 0...130 deg C with a resolution of 0.1 deg C. The BTU meter should have a built in minimum 8 digit LCD display for display of parameters, values and faults. The meter should be compatible with the BMS system. The minimum function to be provided by the BTU meter is as under:

- Calculation and storage of maximum values
- Storage of billing data
- Measurement of tariff dependent data
- Storage of 13 monthly cumulative energy/volume values in EEPROM.
- Detection of faults
- Display of values , parameters and faults
- Selectable scope of display
- Test and service functions.

The BTU meter should have a minimum sampling time for flow every 3 seconds and temperature 24 seconds. Possible displays to be indicated are KWH, MWH, GJ, MJ, KW, m³, m³/hr, h and Deg C. The heat meter should have a minimum accuracy of class 2 with CE conformance.

41.0 DDC PANELS

The out-station panel housing the DDC controllers shall be located inside the conditioned area. Proper care shall be taken to ensure that there is no induction problem between the control and power cables. These panels shall be IP54 and supplied by the specialist controls supplier.

The DDC controllers located inside these out-station panels shall provide the required signals to the various equipments connected to these DDC controllers. The DDC controllers shall be capable of accepting digital input signals in the form of volt-free contacts from Motor control centres. The MEP contractor shall co-ordinate this activity.

All these outstations shall be connected with a communication bus cable and terminated to the BMS central station. The BMS supplier shall supply these bus cables.

It should be possible to connect the Portable hand held terminal to be connected to any of these panels and talk to any other DDC controllers on the same bus.

42.0 Training

All training shall be by the BMS contractor and shall utilise specified manuals and As-Built Documentation

Operator training shall include total seven sessions each of six-hour encompassing:

- Modifying text and graphics
- Sequence of operation review
- Selection of all displays and reports
- Use of all specified OS functions
- Use of portable operators terminals
- Trouble shooting of sensors (determining bad sensors)
- Password assignment and modification

The training shall be under taken in two phases. One training session shall be conducted at system completion, and the other shall be conducted within forty-five days of system completion.

43.0 Warranty

All component, system software, parts and assemblies supplied by the BMS contractor shall be guaranteed against defects in materials and workmanship for one year from the acceptance date.

Labour to troubleshoot, repair, reprogram, or replace system components shall be furnished by the BMS contractor at no charge to the owner during the warranty period.

All corrective software modifications made during warranty service periods shall be updated on all user documentation and on user and manufacturer archived software disks.

SECTION VII

SPECIFICATION FOR CLOSED CIRCUIT TELEVISION SYSTEM

1.0 General

Closed circuit Television and surveillance system remain an ideal method for remotely monitoring and detecting unauthorized entry and to protect the building. As the hospital is continuous mass moving place CCTV and surveillance system become inevitable for safety measure.

The CCTV cameras have been proposed in all important common areas inside the building and also in out side near the entrance so as to have a complete surveillance of the entire campus. The location of the outside and indoor cameras has been marked in the plans and a list containing the location has also been enclosed.

The work under this system shall consist of design, supply, installation, testing, training & handing over of all materials, equipment's and appliances and labor necessary to commission the said system, complete with Hi-Speed Dome Cameras, Vandal proof varifocal dome camera for outdoor, Varifocal and fixed dome camera for Indoor , Digital Video Recorder and Monitor. It shall also include laying of cabling, necessary for installation of the system as indicated in the specification and Bill of Quantities. Any openings/chasing in the wall/ceiling required for the installation shall be made good in appropriate manner.

2.0 Equipment

The CCTV System shall comprise of Indoor Varifocal dome camera, Vandal proof varifocal dome camera for outdoor, Hi-Speed dome Camera, Digital Video Recorder and 26 Inch TFT colour Monitor.

3.0 Indoor Varifocal Dome Camera:

The Dome camera unit shall be 1/3" Sony CCD type Color and shall provide a minimum of 480 TV lines resolution. It shall be possible to use lenses of 3 -9 mm focal length. The complete unit shall be housed in a dome and base unit, both preferably made from injection moulded plastic. It shall be possible to adjust the camera head inside the dome in both the planes so that it can be wall or ceiling mounted. The camera shall operate on 12 volts D.C. The Camera shall comply with the enclosed datasheet.

4.0 Technical Specifications for Indoor Varifocal Dome Camera:

Image Sensor	1/3" Sony Super HAD CCD
Effective Pixels	PAL: 752 (H) x 582 (V)
Scanning System	2:1 Interface, V 50Hz, H 15.625 KHz
Video Output	1 Vp-p, 75 ohms unbalanced
Resolution	480 TV Lines
Minimum Illumination	1.0 Lux F1.4
White Balance	Auto Tracking 2500*K - 9500*K
Back Light Compensation	Auto (center area)
Gain Control	Auto AGC
Shutter Control	AES: 1/50 (60) - 1/100,00 sec.
S/N Ratio	more than 48dB
Gamma Correction	`0.45
Lens	Built-in Varifocal Lens 3-9mm V
Operating Temperature	+10* C to +45* C
Power Supply	DC 12V +/-10% tolerance
Power Consumption	210 mA \pm 10 %
Dimension	H: 90 (mm) x 106mm Dia

5.0 Outdoor Vandal proof Varifocal Dome Camera:

The Dome camera unit shall be 1/3" Sony CCD type Color with Day night feature and shall provide a minimum of 540 TV lines resolution. It shall be possible to use lenses of 3.5 -9.5 mm focal length (9-22mm varifocal Lens as optional lens). The complete unit shall be housed in a dome and base unit, both preferably Vandal proof housing of IP 66 rated suitable for indoor and outdoor use. It shall be possible to adjust the camera head inside the dome in both the planes so that it can be wall or ceiling mounted. The camera shall operate on 12 volts D.C. The Camera shall comply with the enclosed datasheet.

6.0 Technical Specifications for Outdoor Vandal proof Varifocal Dome Camera:

Image Sensor	1/3" Sony CCD
Effective Pixels	PAL: 752 (H) x 582 (V) P
Scanning System	2:1 Interface, V 50Hz, H 15.625 KHz
Synchronization	DC: Internal / AC: Line lock
Video Output	1 Vp-p, 75 ohms unbalanced
Resolution	540 TV Lines
Minimum Illumination	0.05 Lux / F1.4
White Balance	Auto Tracking 2500*K - 9500*K

Back Light Compensation	Auto (center area)
Gain Control	Auto AGC
Electronic Shutter	Auto
S/N Ratio	more than 58Db
Gamma Correction	`0.45
LED	28 Pieces
IR Range	20 meters
Day Night	Color to Monochrome switched by ICR Filter, under low light
Lens	3.5 to 9.5 mm Varifocal DC Iris (9-22mm optional) V
Operating Temperature	-10* C to +45* C
Power Supply	AC 24V / DC 12V \pm 20% (dual power)
Power Consumption	1R OFF 220mA / IR ON 650 mA A (under DC 12V) A
Dimension	150 (mm) x 80mm

7.0 Hi-Speed outdoor Pan/Tilt/Zoom Color Dome camera

The Dome camera system would be consisting of a 1/6" image format, DSP color CCD camera with a 18X Optical zoom and 12X digital zoom auto-iris lens delivering the power of 216X zoom to ensure that the finest details are captured. The Unit shall have a camera with 480 TV lines and auto focus lens, a high-speed pan/tilt in a dome enclosure. The enclosure for outdoor pan tilt dome camera shall be weatherproof and constructed from die cast aluminum. The High speed dome shall have an integral RS-485 communication channel for direct control via the Digital Video Recorder.

The auto dome shall contain an integral 360-degree pan/tilt device. This variable speed pan/tilt shall be capable of operating in the manual mode to speeds up to 150 degree per second (variable speed). The camera shall operate on 24 volts A.C. The auto dome system shall be compatible with the Digital Video Recorder.

The Camera shall comply with the enclosed datasheet.

8.0 Technical Specifications for 1/4" Hi-Speed Dome Camera :

Image Sensor	1/4" Sony Ex View HAD CCD, PAL:800 Pixels
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TV System	2:1 Interface, PAL V:50Hz, H:15.625KHz
Horizontal Resolution	480 TV Lines
Synchronization	Internal / V-Lock
Optical Lens	18X Zoom, f=4.1 – 73.8mm (F1.6-3.8)
Digital Zoom	12X (Upto 216X with Optical Zoom)
AGC	Auto
Minimum Illumination	0.1 Lux (F1.4, 1/50s PAL), 0.01 Lux (1/3s PAL)
S/N Ratio	>50dB
BLC	On/Off
Shutter Speed	Auto: 1/50 - 1/10000, Manual: 22 steps
White Balance	ATW (2000°K - 10000°K), One Push WB
BL Compensation	Auto, Manual , Backlight Compensation
Focusing system	Auto (Sensitivity: Normal , Low)
Focus	Auto / Manual
Day / Night Function	Yes, with infrared IR-Cut (Auto / Manual)
Preset	4 sequences each one with 32 preset
Privacy Zone	24 Zones
On- Screen Display	Yes
Interace	RS-485
Protocol	Europlex, Pelco - D/P, VCL, Kalatel, Emitec, Lin, Vicon
Alarm Function	4 Inputs / 1 Output
Emission & Safety Standard	CE Approval
Power Supply	AC 24V +/- 10% / 50Hz +/- 1 Hz
Operating Temperature	30% - 90% RH / 0°C - + 60°C
Power Consumption	50W (max)
Weight	1343g (Excluding housing)
Dimension	223.7mm (H) x 1343mm(D), about 5.3 inches

9.0 16 Channel Digital Video Recorder:

The Digital Video Recorder (DVR) shall have on board Ethernet and shall be able to integrate with the Integrated Security Management Software (ISMS).

The DVR shall include, but not limited to the following

- The DVR shall use H.264 compression technology and shall have on board Ethernet port
- The DVR shall have embedded Linux operating system and shall function as a standalone unit. For either programming or normal operation, it shall not require the use of a computer, special monitors or any other special peripheral devices.
- The DVR shall have internal hard disk drives with SATA interfaces. Internal HDD shall be able to support up to a maximum of 2TB storage
- The DVR shall have Triplex capability that allows to record, playback and view live images simultaneously
- The DVR shall have a built-in web server and it shall be possible to do the configuration through a web browser over the IP network
- The DVR shall have the capability to record and playback real time video at CIF resolution.
- The DVR shall use a battery internally to back up memory that stores the time, date and all internal programming functions
- The DVR shall have an easy to ready on screen text and menus. It shall also allow the user to change the position of On screen display
- The DVR shall have buttons, jog / shuttle integrated into the front panel to allow menu navigation, set up and control of unit, without the need of any external device
- The front panel buttons shall be capable of controlling / navigating Pan / Tilt / Zoom functions of PTZ cameras connected to the unit
- The DVR shall the following the following option
 - a. The unit shall allow the user to select different resolution for each channel
 - b. The unit shall have the option to select either different frame rate for each channel.
 - c. The unit shall allow the option to select either Fixed or Variable bit rate for each channel. The bit rate shall range from 32 Kbps up to 2 Mbps

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- The DVR shall have the following record mode
 - a. Continuous
 - b. Manual
 - c. Motion Detection
 - d. External alarm
 - e. Motion & Alarm
 - f. Motion or Alarm
- The DVR shall allow setting up of privacy mask for each camera using an on screen menu. Each camera shall have the possibility to set at least 4 privacy mask area
- The DVR shall have a minimum of one audio input channel for every video channel and additional audio input to provide bi-directional audio. The compressed audio bit rate shall not exceed 16Kbps
- The video and audio signals shall be synchronized and the DVR shall have the option of having a mixed stream (Video & Audio) or a Video only stream
- The DVR shall the following video output
 - b. Multi-screen / Sequential – BNC Type
 - c. Auxiliary Video output – BNC Type
 - d. VGA
- The DVR shall have one digital alarm input for each video channel and a minimum of 4 relay outputs
- The DVR shall provide automated alarm handling. Upon receipt of an alarm, shall have the capability to change the resolution and frame as defined in the alarm recording settings
- In addition to changing of record settings upon receipt of an alarm, the DVR shall also be capable to provide relay output operation
- The DVR shall also have the capability to integrated with access control system controllers, intruder alarm panels and other security control equipments to receive alarm signals from those devices and perform alarm handling over IP network
- The DVR shall support pre-alarm recording maintained in a buffer and shall append this buffer to the beginning of all recorded alarms. The DVR shall

continue to record with the alarm record settings until the alarm is reset or acknowledged.

- The DVR shall provide the option of single channel as well as multi-channel playback
- The DVR shall provide extensive search capabilities for archiving, restoring and playback operation.
- The DVR shall have the capability of archiving the recorded images from internal hard disk to an external medium
- The DVR shall support USB HDD, USB CD R/W, USB DVD R/w
- The DVR shall allow the option to set 'STOP RECORDING' or OVERWRITE' when the hard disk is full
- The DVR shall support recording of all images with a digital watermark
- The DVR shall support Infra-red Remote control to operate, configure and navigate the menus. The remote control shall also support PTZ controls
- The DVR shall support configuration / operation through any of the following
 - DVR Front panel buttons
 - Remote client viewer software over the network
 - Integrated Security Management software (ISMS)

10.0 Technical Specifications for DVR:

Operating system	Embedded Linux
Network Ready	Yes
Built-in web server	Yes
System Control	Front button / Remote control / Tracer Viewer/Euronet
Video Compression	H.264
Video Channel Input	16
Video Output	a) Multiscreen / Seq output: BNC - (1.0Vp-p, 75Ω)
	b) VGA - Supported resolution: 800x600 / 60Hz, 800x600 / 75Hz, 1024x768 / 60Hz
Playback Video	2CIF @ 6FPS / Ch, CIF @ 25FPS / Ch

Network transmission Bit	32Kbps to 2 Mbps
Audio Input	4
Audio Output	1 Channel
Audio Bit rate	16Kbps
HDD Interface	SATA
HDD Capacity	2000 GB (Max)
Multi-zone motion detection	Yes
Camera Block (Tamper) alarm	Yes (Using VGA or Main Monitor)
Video Signal Loss alarm	Yes (Using VGA or Main Monitor)
Alarm Inputs	16 x Digital Inputs
Relay Outputs	4
Area Masking	Yes, Multizone
Water Mark	Yes
Communication Interface	1 X RJ45 10M/100M Self-adaptive Ethernet Interface, 1X RJ45 RS232 Port and 1 RS485 PTZ port
Keyboard	1 Port (D+, D-)
DVD /RW	Yes, External
USB	Yes
Viewer Software	Tracer Viewer, EuroNET (requires additional license))
Protocols Supported	Multiple including Pelco D (Contact Sales team for complete details)
Power Supply	230 V AC
Working Temperature	-10 to +55 Deg C
Working Humidity	10 to 90%

11.0 26" Color TFT Monitor

The Color monitor shall be suitable with the standards of the selected cameras. It shall be 26 inch TFT monitor. It shall provide a bright, clear and well-defined picture display on the screen. All controls for brightness, contrast etc. shall be provided on the front panel for readily adjusting the levels of the video signal. The rear panel shall be provided with input and output BNC connectors for

coupling the video output to other Monitors. The video monitors installed shall be minimum 19" size.

12.0 Technical Specifications for 26" TFT Color Monitor

Type	26" color TFT active matrix LCD
Display Area	16.1" horizontal x 10.0" vertical; 19" diagonal
Optimum Resolution	Resolution 1440x900
Contrast Ratio	700:1 (typ)
Viewing Angles	160° horizontal, 165° vertical (CR>5)
Response Time	2ms (typ)
Light Source	Long life, 40,000 hrs. (typ)
Brightness	300 cd/m2 (typ)
Panel Surface	Anti-glare
Video	RGB analog (75 ohms, 0.7 Vp-p)
Sync	H/V separated (TTL)
Frequency	Fh: 30~82kHz, Fv: 50~75Hz
COMPATIBILITY	
PC	VGA up to 1440x900 non-interlaced
Mac®**	Power Mac™ G3/G4/G5 up to 1280x1024
Analog PC	15-pin mini D-sub
Power	3-pin AC plug (CEE22)
Voltage	AC 100–240V (universal), 50/60Hz (auto switch)
Consumption	48W (typ)
Speakers	2x2-watt
Controls:	
Basic	Power, 2, up, down, 1
On View®	Auto image adjust, brightness, contrast, View Match® color adjust
	(sRGB, 9300K, 6500K, 5400K user color), H. position, V. position, H. size, resolution notice
	OSD position, OSD timeout, OSD background, fine tune, sharpness, language, recall, volume, mute

OPERATING CONDITIONS	
Temperature	32–104 °F (5–35 °C)
Humidity	20–80% (non-condensing)
Physical (mm)	450mm x 434mm x 209mm
Physical (in)	27.7" x 17" x 8.2"
Regulations	UL, cUL, FCC-B,CB, CE, WEEE, ISO13406-2

13.0 Training

All training shall be by the contractor and shall utilize specified manuals and As-Built Documentation

Operator training shall include total seven sessions each of six-hour encompassing:

- Modifying text and graphics
- Sequence of operation review
- Selection of all displays and reports
- Use of all specified OS functions
- Use of portable operators terminals
- Trouble shooting
- Password assignment and modification

The training shall be under taken in two phases. One training session shall be conducted at system completion, and the other shall be conducted within forty-five days of system completion.

14.0 Warranty

All component, system software, parts and assemblies supplied by the contractor shall be guaranteed against defects in materials and workmanship for one year from the acceptance date.

Labour to troubleshoot, repair, reprogram, or replace system components shall be furnished by the contractor at no charge to the owner during the warranty period.

All corrective software modifications made during warranty service periods shall be updated on all user documentation and on user and manufacturer archived software disks.

SECTION VIII

TECHNICAL SPECIFICATIONS FOR DATA NETWORKING

SCOPE:

Supply, Installation, testing and commissioning of Active and Passive Components for CONSTRUCTION OF Super Speciality Hospital for GOVERNMENT RAJAJI HOSPITAL AT MADURAI, TAMIL NADU Project and the required Data Networking shall be the latest state of the art technology. The system needs to cater to the Hospital management functions for the complete hospital.

1.0 DESIGN CRITERIA

The Server Room is located in the 1st Floor (Service Room) of the Hospital building.

The design is based on the considering One Core Switches required no Edge Switches.

The Active and Passive components in this case shall be as per the following specifications.

2.0 PASSIVE COMPONENTS

2.1 STANDARDS AND REGULATIONS

This Invitation to Tender (ITT) provides a description for a generic structured cabling system based on the known and current standards for Category 6 / Class E systems. The object of the standards is to define the structured cabling independently of the applications, which it is capable of supporting. This Tender document covers the design, supply, installation, testing and commissioning of a Category 6 cabling system.

The aim of this ITT is to describe a **Category 6 / Class E** universal cabling system which will function for voice, data and LAN communications, for video applications etc. The cabling system is also open to new applications which require an **ISO/IEC 11801** cabling system of Class E /Cat 6 as defined in the latest edition of the standard: **ISO/IEC 11801: 2002**. Furthermore, to allow for future demands, the cabling system must be easy to expand and maintain.

The terminology and references in this document as well as the Link/Channel Performance figures for Class E are based on **ISO/IEC 11801: 2002**.

The data sheet showing the guaranteed values for the material proposed will be attached by the vendor to his tender documents.

All proposed components including the patch cords have to be produced by the same manufacturer. This issue will ensure that a « **Class E Channel Warranty** » can be obtained from the manufacturer. When using the best grade of Cat.6 patch cords available from the cabling system manufacturer, the latter must guarantee an additional minimum channel margin of +6dB ACR.

2.2 HORIZONTAL CABLING

2.2.1 HORIZONTAL DISTRIBUTION CABLE

The horizontal 4 pair cable shall be **Category 6 UTP** to meet the quality and performance criteria necessary to ensure correct operation of the installation in future and compliance with the warranty.

The installation design and routing of all cables shall take account of the manufacturer limits for the continued performance of the cables and the compliance with the warranty.

The cable shall be a 4 twisted pair cable with AWG 24 conductors. Having an external sheathing in a material that does not give off toxic fumes (Zero Halogen) in case of fire and offer flame propagation retardant properties. Trace ability numbers should accompany the cable supplied from the manufacturers packaging to assist in quality validation of the installed cable.

In the construction of the cable cross-talk performance shall be maintained using a **C³ (Central dielectric Cross-talk Cancellation)** member set between the 4 pairs.

All pairs must have impedance of 100 Ohms, with a tolerance of +/- 15 Ohms.

Insulators in standard Blue/White, Orange/White, Green/White, Brown/White colours must cover the conductors.

2.2.2 INFORMATION OUTLETS (I/O)

The connector shall be fully compliant to the **IEC 60603-7-4** standard that define the screened Cat.6 connector to be used to form a Class E channel as specified in the **ISO/IEC 11801:2002** standard.

Each connector shall provide both T568A and T568B colour code identification for the pins at the rear of the connector. The punch down is to be in accordance with the T568B colour code. Reassignment of pairs is forbidden.

All conductors from the 4 pair cable are to be terminated on the respective contacts. To avoid installation errors, the wire organiser of the snap-in connector must be identified by the same standard colour coding as the wires.

All Category 6 RJ45 connectors shall be fully compliant with the **ISO/IEC 11801:2002** standard.

All Category 6 RJ45 connectors shall be reusable.

When the Category 6 RJ45 connectors are to be reused, this shall be done in a safe and reliable way.

For this reason, a tool specially developed by the manufacturer shall be used.

In the case of a 3 or 4 connector Channel with CP, a specific version of connector having IDC contact suitable to receive stranded cable shall be used.

All outlets are fitted with removal shutters, which can be replaced by colour-coded shutters (red, green, blue, and yellow) available from the manufacturer standard product range.

The presentation of the outlet shall provide for labelling and identification. A transparent window shall protect the labelling tag.

A. SNAP-IN / KEYSTONE FORMAT

The dimensions of the Snap-in format connectors are 22.95 mm x 16.3 mm x 28.6 mm (H x W x D)

The same format connectors (unscreened) shall be used on each link.

The connector fits in specific structural hardware for Snap-in format of third parties. If not available, the Snap-in connector can be used in combination with a keystone clip and specific structural hardware for keystone connectors.

2.3 COPPER PATCH PANELS (RJ45)

Patch panels must have 19" equipment practice dimensions to permit mounting in standard cabinets, racks or bays.

The vendor shall make their proposals for this tender using 24 port Snap-in format (Modular) patch panels equipped with a cable management mechanism that provides strain relief, earthing and grounding features.

The presentation of the Patch Panel shall provide for labelling using a printed numbering system.

If baluns, circuit cross over or impedance matchers are used, these shall be external to the Patch Panel.

The connector shall provide both T568A and T568B colour code identification for the pins at the rear of the connector. Patch panel outlets must have each Category 6 RJ45 connector, connected separately. The punch down is to be in accordance with the T568B colour code. Reassignment of pairs is forbidden.

All conductors from the 4 pair cable are to be terminated on the respective contacts.

To avoid installation errors, IDC blocks must be identified by the same standard colour coding as the wires.

Each Patch Panel shall provide a means to locate and clamp the incoming cables without causing damage to the cable or affecting the performance of the Link.

The installer must avoid any risk of cable pinching or compression during the installation or termination of the cables. Therefore the use of Velcro cable ties is preferred.

In the rack, the Patch Panels shall be separated by metallic patch-guides that have a closed front to protect the patch cords. The height of these guides will be 1U or 2U depending on the layout of the rack.

The Patch Panel shall provide an automatic contact with the metal frame of the cabinet in order to ensure grounding.

2.4 PATCH CORDS

To achieve a **Class E Channel performance** all Patch Cords shall be Category 6 rated.

All patch cord cable will be made from PVC

2.4.1 DATA PATCH CORDS

The Category 6 cords must be fitted with Category 6 RJ45 plugs, booted at each connector. The characteristic impedance of the pairs must be identical to that of the horizontal cables. The Patch Cords shall have a guaranteed performance level of greater than 750 insertions without degradation to the performance level of the solution.

The cable used for the Patch Cords shall be Category 6 PVC patch cable. The cable shall be a 4 twisted pair cable with stranded conductors. Trace ability numbers should

accompany the cables supplied from the manufacturers packaging to assist in quality validation of the installed cable.

All pairs must have an impedance of 100 Ohms.

2.5 CLASS E LINK OR CHANNEL

Manufacturer should demonstrate guaranteed minimum worst-case performance to be compliant with class E channel performance according to the **ISO/IEC 11801: 2002** standard.

Components used must be compliant with the Category 6 standard mentioned above and the manufacturer should be able to demonstrate independent Delta verification.

The performance of both the components and the link and channel should show stable performance up to 250MHz in order to allow for possible future applications requiring crosstalk cancellation up to 250MHz.

The system supplier must be able to demonstrate in house design and manufacturing expertise for all components used (e.g. cables, outlets, panels and cords) in order to ensure compatibility of system.

2.6 BACKBONE CABLING

2.6.1 VOICE BACKBONE

This backbone will link the Floor Distributors to the Voice Main Distribution Frame.

A. MULTI PAIR VOICE CABLES

To meet the Standard cabling practices outdoor grade Telephone Multi-pair cable may be used to connect the Inter-building distributors. This cable should also contain a separate earth conductor in addition to the required pair content. The number of pairs in the backbone cable for each voice circuit will be dependent on the type of PABX the client is using. As a guide a minimum of one pair per circuit should be used however a maximum of three pairs per voice circuit may be required, this will need to be clarified with the client prior to commencement of the project.

For indoor risers or backbones Category 3 or 5 Multi-pair cable (25, 50 or 100 pairs / impedance: 100 Ohms / 24 AWG solid copper wire) will be used to connect the Intra-building distributors. The number of pairs in the backbone cable for each voice circuit will be dependent on the type of PABX the client is using.

B. VOICE PATCH PANEL

The Telephone multi-pair cable arriving from the Main Distribution Frame (MDF) will be terminated in the Floor Distributor

2.6.2 DATA BACKBONE

This backbone will link the Switches located in the Floor Distributors (FD) to the Data network server through the Building Distributor (BD).

A. OPTICAL FIBER CABLE

The manufacturer shall provide the choice between the 7 different types of fibres described below. Enhanced OM1, OM2 & OM3 fibres providing warranted extended distance for the transmission of high rate data signals shall be available to avoid limitations due to bottlenecks in the longest building and campus backbone links. The choice of fibre will be made according to the present and future bandwidth needs for the longest OF backbone links.

If the 10Gbit Ethernet application has to be supported, the OM3 or OM3 enhanced fibres shall be used to ensure the transmission of the signal over 300 (or 450 m) metres at 850nm.

Due to their limited bandwidth, the use of OM1 optical fibres to form the backbones for Class E cabling systems is not recommended.

Technical Data – Fibre Transmission

Fibre type	SM (G652)
Attenuation	@1310 nm
Typical	≤ 0.35
Max.	≤ 0.42
Attenuation	@1550 nm
Typical	≤ 0.22
Max.	≤ 0.28
Application	
Fast Ethernet	-
1 Gigabit Ethernet	-
10 Gigabit Ethernet	-

Fibre Channel 1Gbps	-
Fibre Channel 2Gbps	-
Fibre Channel 4Gbps	-
Application	Transmission max. distance @ 1300 nm
Fast Ethernet	2.000 m
Gigabit Ethernet	10.000 m
10 Gigabit Ethernet	10.000 m

B. TIGHT BUFFERED INDOOR AND LIGHT DUTY OUTDOOR WATERPROOF OFC CABLE

This optical fibre cable shall be used for indoor home run back to patch panel routes in risers, horizontal applications and for outdoor duct applications where there is permanent water present i.e. flooded duct. This cable shall be selected where the required fibre count is from 2 to 24.

The cable shall be suitable for connector manufacturer field termination processes (SC or LC connectors) and for OF pigtails splicing.

The cable shall be a dry construction i.e. with no gel content. The jacket material shall be waterproof LSZH with a minimum fire performance of IEC 332 part 3C.

Every fibre shall be 900µm diameter secondary coated each being a different colour or suitably identified for termination identification.

The cable strength member shall be glass yarn laid longitudinally between the fibres and the inside wall of the outer jacket. The cable shall be dielectric construction, i.e. with no metallic content.

Applications support

FDDI	100 Mbps
Ethernet	10 base FL
	100 base FX
	1000 base SX
	1000 base LX
Fibre Channel	266 Mbps

	1000 Mbps
ATM	155 Mbps
	622 Mbps

C. OPTICAL FIBER PATCH PANEL

Optical fibre Patch Panels shall be mounted in 19" frames of the cabinets. The patch panels shall be equipped with a mechanism that ensures the retention and support of incoming cables. The patch panel shall be designed with a sliding mechanism enabling front side installation and maintenance work to be carried out without having to remove the entire panel.

The patch panel shall provide facilities to recess the front connector plate deeper than the front of the 19" rails of the cabinet. This will provide sufficient bend radius for the patch cords once connected to the panel. This shall also prevent damage to the patch cords when the cabinet doors are closed.

Direct Termination of the connectors (SC & LC) on to the fibres as well as splicing of pigtails (SC, LC & MT-RJ) shall be possible.

The Patch Panel shall provide management for 1m of fibre per link after breaking the fibres out from the cable.

The front plate of the 24 port modular Patch Panel shall be compatible with the following connector types: SC, LC and MT-RJ.

Standard LC, SC, DSC and MT-RJ snap-ins couplers shall be available to load the modular patch panel.

The fully loaded panel (One height unit or 1HU) shall support up to 24 fibres when working with SC snap-in couplers and up to 48 fibres when working with LC or MT-RJ snap-ins couplers.

Up to four optional splice trays should be supported to manage up to 48 splices.

In the panels, the fibres have to be wired in such a way that the dual OF channel polarity is maintained. Wiring of the fibres has to be done according to the guidelines provided by the manufacturer.

D. OPTICAL FIBER PATCH CARDS

The Fibre snap-ins adapters will be connected to the active equipment by means of "Cross-over" duplex patch cords. In order to maintain the duplex OF channel polarity. The patch cords should be available in lengths of 2 and 5 meters and have a LSHF-FR outer sheath.

When using SM optical fibre cables, patch cords produced with the same SM fibre have to be installed.

b) Single mode connector performances

- Maximum insertion loss at 1300nm (IEC 61300-3-4) 0.5dB (ST, LC & SC)
- Minimum return loss (IEC 61300-3-6) 50dB
- Durability (IEC 61300-2-2) < 0.2dB

c) Compliance

- SC connector compliant with IEC61754-04 specifications

2.18 TESTING

The manufacturer of the cabling system shall provide copper (Data) and optical fibre testing procedures that clearly describes the tools and settings to be used to ensure correct measurements of the system.

2.18.1 TESTING OF CLASS E

100 % of the installed horizontal links have to be tested. The testing procedure has to comply with the standard **ISO/IEC 11801: 2002** for Class E, according to the procedure for “Channel or Permanent Link”. The measurements shall be done using Level III or IV testing equipment. Channel testing shall be preferred.

The testing equipment must be yearly calibrated by the manufacturer and the copy of the calibration certificate must be included in the warranty request.

The following parameters have to be tested:

- ✓ Pair continuity (wiremap)
- ✓ Pair length
- ✓ DC Loop resistance per pair
- ✓ Insertion loss (Attenuation) per pair
- ✓ Next and Power sum Next for every pair combination
- ✓ Next and Power sum Next for every pair combination
- ✓ The ACR (ratio NEXT/ insertion loss) for every pair combination
- ✓ Return Loss (impedance match, retransmitted signal)

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The complete test results of all the installed links or channels have to be collected in a certification file. It is preferred to have the test result in electronic format to facilitate the certification procedure.

Apart from all the test results mentioned above, a few more documents have to be added to the file: a list of material used for the project, a design of the network, a Cable schedule per distributor and finally all the necessary co-ordinates of the persons responsible of the project.

2.7.2: BMS materials/ System Make: Siemens/Honeywell/Blue star/Schneider

Class E Permanent Link : Specific values for links guaranteed as in **ISO/IEC 11801: 2002**.

Freq.	IL	NEXT	PS NEXT	ACR	PS ACR	ELFEXT	PS ELFEXT	TRL	Prop. delay
	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(ns)
4	4,0	64,1	61,8	60,1	57,8	52,1	49,1	21,0	504
10	5,6	57,8	55,5	52,2	49,9	44,2	41,2	21,0	498
16	7,1	54,6	52,2	47,5	45,1	40,1	37,1	20,0	496
20	7,9	53,1	50,7	45,1	42,7	38,2	35,2	19,5	495
31,25	10,0	50,0	47,5	40,0	37,5	34,3	31,3	18,5	494
62,5	14,4	45,1	42,7	30,7	28,2	28,3	25,3	16,0	492
100	18,5	41,8	39,3	23,3	20,8	24,2	21,2	14,0	491
155	23,5	38,7	36,2	15,2	12,6	20,4	17,4	12,1	491
200	27,1	36,9	34,3	9,9	7,2	18,2	15,2	11,0	490
250	30,7	35,3	32,7	4,7	2,0	16,2	13,2	10,0	490

Class E Channel : Specific values for links guaranteed as in **ISO/IEC 11801: 2002**.

Freq.	IL	NEXT	PS NEXT	ACR	PS ACR	ELFEX T	PS ELFEX T	RL	Prop. delay
	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)	(ns)
4	4,2	63,0	60,5	58,9	56,4	51,2	48,2	19,0	562
10	6,6	56,6	54,0	50,0	47,4	43,3	40,3	19,0	555
16	8,3	53,2	50,6	44,9	42,3	39,2	36,2	18,0	553
20	9,3	51,6	49,0	42,3	39,7	37,2	34,2	17,5	552

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31,25	11,7	48,4	45,7	36,7	34,0	33,4	30,4	16,5	550
62,5	16,9	43,4	40,6	26,5	23,7	27,3	24,3	14,0	549
100	21,7	39,9	37,1	18,2	15,4	23,3	20,3	12,0	548
155	27,6	36,7	33,8	9,1	6,2	19,5	16,5	10,1	547
200	31,7	34,8	31,9	3,1	0,1	17,2	14,2	9,0	547
250	35,9	33,1	30,2	-2,8	-5,8	15,3	12,3	8,0	546

2.19 VERTICAL COPPER TESTING

Multi-pair copper backbone cable will be continuity tested only with the results presented in spreadsheet format.

1.0 ACTIVE COMPONENTS

3.1 CORE SWITCH SPECIFICATIONS

	Switch - 24 port 10/100/1000baseT		
Sl.No	General Specification	Compliance (Yes or No)	Remarks
A	Switch Architecture General Specification		
1	The switch shall be stackable 19 inch Rack mountable unit with the rack mount kit		
2	The switch should support external Redundant 230V AC power supply.		
B	Payload modules support		
1	The Layer 3 switch should supports 24 ports of 10/100/1000baseT including combo 4 1000BaseX SFP slots.		
2	In case the routing license is needed for routing functionality, the same should be included from day 1		
3	The switch should be supplied with latest firmware software.		
C	Performance Architecture		
1	The switching capacity of switch should be 48 Gbps		
2	Should support stacking capacity of 96 Gbps on the dedicated stacking ports		

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3	The switch should support closed loop stacking for redundancy where all units in stack are treated as one single device allowing common stack management feature,firmware upgrade, port mirroring, vlan definition and link aggregation to be performed on the		
4	The switch should be stackable upto 8 units in stack using separate configured dedicated stack ports (No Virtual Stacking)		
5	The switch should support 35 Mpps Switching throughput		
6	The switch should support 16,000 MAC Address		
7	The switch should support 1024 802.1Q port based VLAN with 4096 VIDS		
8	Should be able to do Layer 2/3/4 Classification		
D	The switch should support the following Switching - Layer-2 Services		
1	IEEE 802.1AB – LLDP		
2	LLDP-MED		
3	IEEE 802.1D – MAC Bridges		
4	IEEE 802.1s – Multiple Spanning Trees		
5	IEEE 802.1t – 802.1D Maintenance		
6	IEEE 802.1w – Rapid Spanning Tree Reconvergence		
7	Full/half duplex auto-sense support on all ports		
8	IGMP Snooping v1/v2/v3		
9	Jumbo Frame support (9,216 bytes)		
10	Loop Protection		
11	One-to-One and Many-to-One Port Mirroring		
12	Port Description		
13	Protected Ports		
14	Per-port Broadcast/Multicast/Unknown Unicast Suppression		
15	Spanning Tree Backup Root		
16	STP Pass Thru		
E	The switch should support the following Switching - Layer-3 Services		

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1	Should support ACLs & Extender ACLs		
2	ARP & ARP Redirect		
3	DVMRP		
4	IP Helper Address		
5	Ethernet ARP		
6	RIP v1, v2		
7	ICMP Router Discovery Messages		
8	IGMPv2		
9	OSPF v2		
10	PIM-SM		
11	DHCP/BootP Relay		
12	VRRP – Virtual Router Redundancy Protocol		
13	Static Routes		
14	VLAN-based ACLs		
F	VLAN Support		
1	Generic Attribute Registration Protocol (GARP)		
2	Generic VLAN Registration Protocol (GVRP)		
3	IEEE 802.1p – Traffic classification		
4	IEEE 802.1q – VLAN Tagging		
5	Protocol-based VLANs with Enterasys Policy		
6	IEEE 802.3ac – VLAN Tagging Extensions		
7	Port-based VLAN (private port/private VLAN)		
8	Tagged-based VLAN		
9	VLAN Marking of Mirror Traffic		
G	Quality of Service		
1	8 Priority Queues per Port		
2	802.3x Flow Control		
3	IP DSCP – Differentiated Services Code Point		
4	IP Precedence		
5	IP Protocol		
6	Queuing Control – Strict and Weighted		
7	Round Robin		

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8	Source/Destination IP Address		
9	Source/Destination MAC Address		
H	Security Features		
1	Standard ACLs		
2	Extended ACLs		
3	MAC Address Authentication		
4	MAC locking (Static/Dynamic)		
5	802.1X Port-based Authentication		
6	MAC-based Authentication		
7	The switch should support RFC 3580		
8	The switch should support multiple authentication types per port Simultaneously		
9	The switch should support multiple authentication types Per Port namely 802.1X, Web based authentication and MAC based authentication		
10	The switch should be able to do preventive act of blocking worms and viruses which intent to brings down the entire network.		
11	The switch should be able to control them using Connection Rate Filtering/Throttling that thwarts viruses from spreading by blocking routing from certain hosts exhibiting abnormal traffic behavior.		
12	The switch should Throttle denial-of-service (DoS) attacks or other malicious behaviors that uses high volume ICMP traffic.		
13	The switch should be able to limits authorized list for CLI/Web/Telnet/SNMP management access to the switch to particular authorized hosts		
14	User and IP Phone Authentication on any given port		
15	Password Protection (encryption)		
16	User and IP Phone Authentication		
17	Web-based Port Authentication		
I	Network Management		
1	The switch should support CLI/WEB/SNMP Management		
2	The switch should support multiple Syslog Servers		
3	The switch should support RADIUS Client		

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4	The switch should support FTP/TFTP Client		
5	The switch should support SNMP		
6	The switch should support Telnet – Inbound/Outbound		
7	The switch should support Cisco CDP v1/2 or equivalent		
8	The switch should support configuration File Upload/Download		
9	The switch should support RMON –(Stats, History, Alarms, Events, Filters, Packet Capture)		
10	The switch should support multiple firmware images and configuration files with option for revision roll back		
11	The switch should support Text-based Configuration Files		
12	The switch should support SSH v2 and SSL		
13	The switch should support Multiple local user account management		
14	The switch should support SNMP v1/v2c/v3		

3.2 EDGE SWITCH SPECIFICATIONS

	Edge Switch - 24 port 10/100/1000baseT		
Sl.No	General Specification	Compliance (Yes or No)	Remarks
A	Switch Architecture General Specification		
1	The switch shall be stackable 19 inch Rack mountable unit with the rack mount kit		
2	The switch should be stackable upto 8 units in stack using separate configured dedicated stack ports (No Virtual Stacking)		
3	Stacking Capacity 48 Gbps		
4	The switch should support closed loop stacking for redundancy where all units in stack are treated as one single device allowing common stack management feature,firmware upgrade, port mirroring, vlan definition and link		

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	aggregation to be performed on the		
5	The switch should support external Redundant 230V AC power supply.		
6	Flash Memory should support 32MB		
7	DRAM Memory should be 256 MB		
B	Payload modules support		
1	The switch should support 24 ports of 10/100/1000baseT including combo 4 1000BaseX SFP slots. And 48 ports of 10/100/1000baseT including 4 combo 1000BaseX SFP slots		
C	Performance Architecture		
1	The switch should support scalable Fabric with current requirement to support minimum of 48Gbps for 24 port switch and 96 Gbps or more for 48 port switch.		
2	The switch should support 35.7 Mbps for 24 port switch and 71 Mbps for 48 port switch as the Switching throughput		
3	The switch should support latency based on RFC 1242		
4	The switch should support 16K MAC Address		
5	The switch should support 1024 802.1Q port based VLAN with 4096 VIDS		
D	The switch should support the following Switching - Layer-2 Services		
1	802.1Q – Virtual Bridged Local Area Networking		
2	802.1p – Traffic Class Expediting		
3	Number of Spanning Tree instances should be 3 or more		
4	802.1w – Rapid Reconfiguration of Spanning Tree		
5	802.1s – Multiple Spanning Trees		
6	Auto MDI-X Media Dependent Interface Crossover Detect (Enhanced for non auto negotiating ports)		
7	802.3ad – Link Aggregation supporting minimum 6 groups having 8 ports per group		
8	Jumbo Frame support		

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9	802.3x – Flow Control		
10	Inbound and Outbound Rate Limiting supporting minimum of 64Kbps		
11	Strict and Weighted Round Robin Queuing		
12	Link Flap detection		
13	Spanning Tree Loop Protection		
14	Broadcast Suppression		
15	Directed Broadcast		
16	SpanGuard / Spanning Tree Backup Root support		
17	802.3x (Flow Control)		
18	IGMP Join and leave latency: < 500 mSec		
19	The switch should support minimum 256 IGMP groups		
20	The switch should support One to One and Many to one		
21	• RFC 792 ICMP		
22	• RFC 1256 ICMP Router Discovery Protocol		
23	• RFC 826 ARP		
24	• RFC 1027 Proxy ARP		
25	• Static Routes		
26	• RFC 1058 RIPv1		
27	• RFC 1723 RIPv2 with Equal Cost Multipath Load Balancing		
28	• RFC 1812 RIP Requirements		
29	• RFC 1519 CIDR		
30	• RFC 1112 IGMP		
31	• RFC 2236 IGMPv2		
32	• Secondary's IP addresses per VLAN Interface		
33	• IP Helper addresses (per router / per interface)		
34	• DHCP Server support		
35	IPv4/IPv6 support		

E	The switch should support the following Quality of Service		
1	802.1p (Traffic Class Expediting)		
2	strict priority (SP) or weighted round-robin (WRR)		
3	Marking (TOS Rewrite)		
4	Policy Profiles/Rules		
F	The switch should support the following Priority (802.1p) Classification Capability		
1	Source MAC Address		
2	Destination MAC Address		
3	Source IP Address exact match		
4	Source IP best match (Subnet)		
5	Destination IP exact match		
6	Destination IP best match (Subnet)		
7	UDP/TCP source port		
8	UDP/TCP destination port		
9	UDP/TCP source/destination range		
G	Security Features		
1	• Standard ACLs		
2	• Extended ACLs		
3	• MAC Address Authentication		
4	• MAC locking (Static/Dynamic)		
5	• 802.1X Port-based Authentication		
6	• MAC-based Authentication		
7	• The switch should support RFC 3580		
8	• The switch should support multiple authentication types per port Simultaneously		
9	• The switch should support multiple authentication types Per Port namely 802.1X, Web based authentication and MAC based authentication		
10	• The switch should be able to do preventive act of blocking worms and viruses which intent to brings down the entire network.		
11	• The switch should be able to control them using Connection Rate Filtering/Throttling that thwarts viruses from spreading by blocking routing from certain hosts exhibiting abnormal traffic behavior.		

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12	• The switch should Throttles denial-of-service (DoS) attacks or other malicious behaviors that uses high volume ICMP traffic.		
13	• The switch should be capable of performing a host integrity based on a trusted computing model.		
14	• The switch should be able to limits authorized list for CLI/Web/Telnet/SNMP management access to the switch to particular authorized hosts		
15	User and IP Phone Authentication on any given port		
H	Network Management		
1	The switch should support CLI/WEB/SNMP Management		
2	The switch should support multiple Syslog Servers		
3	The switch should support RADIUS Client		
4	The switch should support FTP/TFTP Client		
5	The switch should support SNTP		
6	The switch should support Telnet – Inbound/Outbound		
7	The switch should support Cisco CDP v1/2 or equivalent		
8	The switch should support configuration File Upload/Download		
9	The switch should support RMON – Statistic, History, Alarms, Host, HostTopN,		
10	The switch should support multiple firmware images and configuration files with option for revision roll back		
11	The switch should support Text-based Configuration Files		
12	The switch should support Daylight Savings Time		
13	The switch should support SSH v2 and SSL		
14	The switch should support Multiple local user account management		
15	The switch should support SNMP v1/v2c/v3		

SECTION IX EPABX AND TELEPHONE SYSTEM

1.0 TECHNICAL SPECIFICATIONS

1.1 SCOPE:

Supply, Installation, Testing and Commissioning of Digital IP / SIP enabled multimedia voice Communication system for CONSTRUCTION OF SUPER SPECIALTY HOSPITAL FOR GOVERNMENT HOSPITAL AT MADURAI, TAMIL NADU Project. The System shall be latest state of the art Technology exchange based on IP Technology. The System needs to cater to the telephone functions for the complete Hospital. The system shall be installed in the Service Room - First Floor of the hospital Building. The connectivity of all the floors from the system shall be through copper cables.

Telephone Connection has been proposed so as to cover all the important and required places. The System offered for the Hospital should be equipped for 280 Extensions (i.e. 260 Analog Extensions and 20 Digital Extensions). The offered system should be expandable by adding necessary cabinets and cards to 1000 Extensions without changing/adding the common control cards, and by tie lining two or more exchanges. 1000 users should be achieved with the same system and documentary proof to be submitted for the same.

2.0 DESIGN CRITERIA

The EPABX system shall be Installed and Commissioned in the First Floor – Service Room of the Hospital building. The Main System, MDF, FCBC and batteries and other system components shall be installed in this Room.

All the cables shall be terminated in this Room. The complete EPABX system shall be managed by a Desktop PC and associated software to be provided with the same. The cabling shall be done for the required number of extensions as per the cabling BOQ Enclosed.

The offered EPABX System and its accessories in this case shall be as per the following Specifications.

3.0 GENERAL

- 1.1 The EPABX System offered shall be TEC approved. Documentary Proof of TEC approval shall be submitted with the offer.

- 1.2 The EPABX System offered shall be QSIG and SIP Ready. Tenderer shall submit QSIG Test certificate of the EPABX exchange offered from an authorized body.
- 1.3 The EPABX system shall be ECMA approved QSIG Compliant and the OEM of the server shall necessarily be a member of ECMA.
- 1.4 The system should support VoIP (Voice over Internet Protocol) / SIP (Session Initiation Protocol). The offered Make and Model with Similar configuration should have been installed in India using IP technology in atleast 5 locations in the last 5 years. Documentary Proof for the same should be enclosed.

4.0 OPERATING AMBIENT CONDITIONS

- i) The offered system shall be compatible to tropical climate prevalent in India.
- ii) The offered system shall be able to operate in ambient temperature range +5 to +40 degrees Celsius.
- iii) The system shall be able to operate in relative humidity of about 30-85%.

5.0 SYSTEM ARCHITECTURE

- i) The system topology shall be fully duplicated and decentralized control.
- ii) The IP Telephony Server shall support remote shelves & IP Access points. IP Access points shall be centrally administrable from the Host system. Distributed switching shall be possible on IP Access points also. The system shall have Universal ports for line/trunk cards. Wherein any peripheral card can be inserted in any slot of the peripheral shelf, thereby is enhancing the flexibility of the Configuration.

6.0 CENTRAL PROCESSING UNIT

The Central Processing Unit of the IP Telephony Server shall be a 32 Bit Hierarchical microprocessor with fully distributed controls to share the load, offering hot stand by configuration with transparent switchover on occurrence of fault, covering all control cards, power supply etc. It shall have Pentium / RISC processor and ability of Busy Hour Call Completion (BHCC) of above 100,000.

7.0 STORAGE MEDIA

The system shall provide world's latest technique of storage media, Magnetic Optical disk, Flash EPROM, for higher reliability and fast booting.

8.0 DUPLICATION / SYSTEM REDUNDANCY

System Redundancy: The EPABX offered shall support Duplicated Control Unit in Hot standby mode. The basic system shall be capable of achieving its ultimate capacity without the need of adding /upgrading CPU. The following Duplication shall be provided with the system for:

- i) Common Control
- ii) Switching Network (TDM/PCM Bus)
- iii) Power supply duplication till the shelf level
- iv) Tones
- v) Main and standby memory

The offered system shall be capable of Hot Swapping of all cards without switching off the system where the necessary cards can be interchanged or replaced even in online conditions.

9.0 OPERATING SYSTEM

The operating system of the IP Telephony Server shall be protected against Loss/alteration of memory due to power failure/unauthorized command or due to any other faulty condition.

10.0 NETWORKING

i) The offered system shall work under the internationally recognized Networking protocol, QSIG for feature transparency throughout the network. The EPABX should support Digital networking of Multi vendor EPABX via QSIG software for feature transparency throughout the network.

ii) The Bidder should have installed the offered system in India where in networking with other make EPABX should have been done through Q-Sig.Documentary proof to be enclosed.

iii) The system shall be capable of integrating with TEC approved PRI/E1 (2MBPS) cards of Direct Inward Dialing and also for connectivity with other voice servers. The system shall support SIP based protocol for internet working of different make IP Telephony Servers.

11.0 SUBSCRIBERS AND TRUNK INTERFACES SUPPORTED

The IP Telephony Server shall support the following:-

- i) So Exchange Interfaces with DSS 1
- ii) S2 Exchange Interfaces with DSS 1
- lii) SIP carrier gateway
- iv) Interfaces for Integral connection of radio cells (DECT Standard)
- v) a/b Interfaces for connection of analog subscribers
- vi) Interfaces for E&M 2/4 wire subscribers
- vii) Interfaces for digital 2 Channel subscribers
- viii) Interfaces for IP subscribers and IP Trunks
- ix) Interfaces for SIP subscribers and SIP Trunks
- x) Interfaces for Wireless IP Subscribers and Wireless SIP Subscribers

12.0 TRUNKS

ISDN (INTEGRATED SERVICES DIGITAL NETWORK): The IP Telephony Server shall be ready for ISDN and only the necessary ISDN BRI & PRI Gateways (Basic Rate Interface & Primary Rate Interface) need to be added for functionality.

The system shall be capable of accepting different types of signals for ISDN BRI & PRI, Ring down, 2W/4W E&M (Ear & Mouth) signaling etc.

The system shall support E1/PRI (30 channel PCM) level DID.

The system shall inherently support IP/SIP Trunks. The Hardware for the same provided shall be of OEM Make only.

13.0 OPERATOR CONSOLE

The offered Operator console should be IP based operator console. Necessary IP card used to connect the operator console should be supplied and also support IP phones connectivity. Minimum of 100 IP phones should be able to connect to the

same IP Card used for Operator Console. The operator console should support the following features.

- User prompts can be set to different language by user
- Distinctive ringing tones
- Call and traffic display
- Call switching/disconnect/intrusion/answering
- Extending incoming calls without announcement
- Serial calls
- Toggling between connections
- Attendant camp-on for external, internal and tie trunk calls
- Attendant loop transfer to another attendant console
- Automatic recall
- Trunk hold/toggle
- Specific personalized calls
- Night service options

14.0 DISTRIBUTED ARCHITECTURE via IP NETWORK

The EPABX offered shall support the IPDA.

Features of IP Gateway to connect distributed system, Interface to connect IP access points via the internal IP network infrastructure. Supports the following performance features:

- IP interface to support up to 120 B-channels to connected access points
- 2 x 10/100 Base-T interface
- Support of voice-based network protocols via IP
- QoS according to IEEE 802.1 d/q and IETF
- DiffServ
- Integrated echo compensation
- Recognition of DTMF tones according to RFC 2833
- Voice compression according to ITU-T G.711 and G.729AB
- Transparent fax-modem support (FMoIP) according to G.711t

Alternatively configurable in mixed mode as

- IP/SIP-subscriber gateway
- IP-trunking gateway

- SIP-carrier/trunking gateway

15.0 SYSTEM DETAILS

- i) System should support Voice, Data and Image (Video) Networking.
- ii) System should also support Call Center Solutions for Public Enquiry system. System should support ACD supporting atleast 20 Agents. Documentary proof to be attached.
- iii) The systems offered should be fully modular and utilize Universal Port Architecture.
- iv) The system should be 100% Non-Blocking with a Switching Matrix to provide more Time Slots than the Total ports of the System Quoted.
- v) The systems should support Level DID applications using Analog / E1 Digital Trunks. The system should support modified R2MFC signaling based on Indian Standards.
- vi) System should support Optic Fiber Transceivers for terminating the Optic Fiber Cable i.e. the system should have direct Optic Fiber Connectivity interface.
- vii) System should have built-in interface for External MOH and Back Ground Music (BGM) as well as External Paging Interface.
- viii) All peripheral cards like analog extension, digital extension, trunks cards etc should be hot swappable.

16.0 IP COMPONENTS

The system should support the following attributes:

- a) LAN interface, Ethernet with TCP/IP protocol
- b) Connection of a server via LAN-LAN router and LAN-WAN (ISDN)
- c) Remote connection to a server/host via ISDN directly via S_0
- d) Remote access to the server
- e) Connection of remote terminals to the server

- f) The offered communication system should have the possibility of distributing Cabinets via IP network.
- g) There should not be any restrictions concerning system or subscriber-functionality in the distributed architecture
- h) The following additional measures should be supported to increase the availability of the system:
 - a) Survivability concept for signaling and payload in case of fail of the IP-network
 - b) It should be possible to connect IP work points to the offered communication server
 - c) The system should provide the same features for IP work points as for traditionally connected subscribers

17.0 IP EXTENSION CARD

- a) The system should support IP extension card.
- b) This should be an integrated card, which should be pluggable in any of the universal slots.
- c) This card should have a 10/100 Ethernet port, which can be connected to the LAN.
- d) IP Phones should be able to connect to the LAN and the same should communicate to the EPABX.
- e) These IP phones should be able to connect on WAN also.
- f) IP phones should be able to be connected on Internet also, if static IP is available.
- g) Bidder should submit detailed datasheet of this card
- h) The networking IP card should support the following,
 - Minimum 30 voice channels should be possible
 - Should support G.711, G.723.1, G.729.A
 - Should be an integrated solution i.e. card based and to be put in any of the universal slots
- i) The system should support feature transparency when IP is used as medium for networking i.e. Intranet or Internet applications. Necessary documentary proof should be submitted
- j) The Same IP Extension Card will have to be used for IP Trunking.
- k) The Same IP Extension Card should also support SIP users.
- l) The Offered system should support SIP Extension and SIP Trunking without any additional interfaces or servers.

18.0 FUTURE EXPANSION REMOTE CABINETS

- a) Remote Cabinets should allow the system to be connected in a distributed topology.

- b) The system should support remote location of maximum 50 cabinets on such a distributed IP topology.
- c) Distance should not be a limitation in such a scenario.
- d) The Switching, Trunks, Operator, Voice Mail etc should be centralized.
- e) The remote cabinets should be able to use all the main system features including Voice Mail and Call Billing etc.
- f) There should be 100% feature transparency between the Main and Remote system i.e. all the main system features should be available in the Remote system.

19.0 SYSTEM MAINTENANCE

- a) System should use Flash-ROM/ MOD for faster booting. Maintenance and Administration terminal should enhance system management with a user-friendly man-machine Interface. It should have the following features.
 - System Database Management
 - System Backups
 - Traffic Data Management. This should on a GUI based console with detailed information about the health of the exchange status of subscriber lines, trunk lines, battery voltage level indication etc.
 - Alarm indication on Display and Printer
 - Display of Software and Circuit card information on terminal
 - System should have Remote Maintenance Modem for on-site PC Programming.
 - On Line Diagnostics of the whole exchange should be provided.

20.0 DECT CORDLESS – SYSTEM

- a) The system supplied should support DECT. It should be possible to interface standalone / integrated multi cell/multi-subscriber cordless system to the DECT standard available..
- b) The offered communication system should support the following system features:
 - Voice and Data Communication should be possible from the handset.
 - Interface with GAP protocol
 - The Handset should support Fax Transfer @ 14.4 kbps

- Roaming facility should be available i.e. same handset can be used in various plants or with different systems at different locations.
- Flexible demand-oriented connect ability of base stations with 4, 8 or 12 voice channels.
- Full integration into the PBX administration and maintenance concept
- System expansion per system up to 100 base stations and up to 500 handsets
- Network-wide roaming
- Downloading and fast hopping for base stations
- ISDN and PBX features should be possible
- Roaming facility should be available i.e. same handset can be used in various plants or with different systems at different locations.
- Back Lighting
- Full privacy is provided on the handset. Voice Encoding / Decoding System technique is 32kbps ADPCM.
- Power Consumption – 10 mw min
- Weight of each handset 100 gm max
- Memory - 100 no speed dial memory
- Scrolling by name or memory location
- Cell Radius – 500 mtr (Open Space)

21.0 SYSTEM EXPANDIBILITY

- i) Vendor should specify the maximum expandable capacity of the quoted exchange and maximum number of remote shelves connected to the main system on IP. Vendor should have installed system with atleast 5 remote shelf with the offered system on IP. Documentation proof to be submitted.
- ii) The System should have the capability of connecting the remote Shelves strictly on LAN only using IP (Internet protocol) not through any other type of connectivity. Single system with IP remote should be offered. Individual system in the remote locations should **not** be interconnected on IP Trunking / E 1 / PRI / E & M / LD. Vendor should provide the documentary evidence for the same.

22.0 SUPPORT

Construction of Super Speciality Hospital for Govt. Rajaji Hospital at Madurai, Tamil Nadu

1. The Bidder shall have a full-fledged service set up in Tamil Nadu and contact details and the name of the service engineer shall be provided with contact numbers.
2. Adequate spares should be maintained at their office for immediate support. The Bidder shall have a remote maintenance center in India.

In case the Bidder is not the manufacturer then separate letters as detailed below are to be attached

3. Letter authorizing the Bidder to quote for this specific tender
4. Letter assuring that the manufacturer will provide all Service and technical support directly to the Buyer and even on 24/7 basis (if required).
5. This letter shall also specify the infrastructure available in India to enable the above service
6. Service centers in India (address with contact person details)
7. Spares stock centers in India (address with contact person details)
8. Bidders failing to enclose the above letter with necessary details asked for shall be summarily rejected.

23.0 SYSTEM FEATURES

23.1 STANDARD SYSTEM FUCTIONS

The features listed below are all required for system call processing and basically shall be available to all analogue, digital or IP- subscribers:

- Rejection of DID calls, if free, busy or incompletely dialed
- Special audible tones after lifting the handset if features have been activated
- Operation with/without DID
- Reaching certain extensions in incoming traffic
- Transmit DTMF signals to public networks
- Multiple trunk group for reaching exchange and/or tie-trunks
- Multiple trunk groups using code dialing
- Auto-timed diversion of incoming calls
- Technical measures to prevent connections
- Different ringing for internal, exchange, emergency, deadline and direct calls

- Closed numbering
- Prevention of DID to certain extensions
- Toll/code restriction in exchange and trunk-to-trunk traffic
- Music or a brief announcement for calls on hold
- Presetting digits
- Digit repetition

23.2 OPEN NUMBERING

It must be possible to freely assign subscriber numbers and connection locations. The call numbers can be of any length up to seven digits.

23.3 VIRTUAL NUMBERING

It must be possible to reproduce, several identical or itself overlapping, call number plans within a system

23.4 TOLL/CODE RESTRICTION ON EXCHANGE TRAFFIC

Toll/code restriction releases exchange call numbers in accordance with the class of service of the subscriber. It must be able to evaluate up to 22 digits per voice, fax and data service. Subscribers with local access shall also be permitted to reach long distance areas by the assignment of up to 6 partial toll accesses.

23.5 TOLL/CODE RESTRICTIONS ON DEDICATED CONNECTION CALLS

Toll/code restriction releases call numbers for the private network in accordance with the class of service for the traffic via the dedicated connections. It must be able to evaluate up to 22 digits for each voice, fax and data service, each subscriber being able to obtain toll accesses with different call number groups.

23.6 PREVENTING ILLEGAL CONNECTIONS

Using the entries in a connection matrix, traffic relations within and between groups of subscribers and trunks can be released or blocked as required.

23.7 HOT – LINE SERVICE WITHOUT DIALING

It is possible to set up extensions so that when the handset is lifted a connection to a programmed destination is set up (hot-line).

23.8 HOT – LINE SERVICE AFTER PAUSE

Extensions can be set up so that after the handset is lifted, a connection is set up to a programmed destination if no dialing takes place within 20 seconds or only partial dialing takes place.

23.9 TRANSMIT DTMF SIGNALS

Special devices, which can be controlled by DTMF signaling, can be dialed up via outgoing external lines. To do this, both the digital dialing information for digital or IP- telephones and the pulses from analog pulse dialing telephones must be converted to DTMF signaling.

23.10 SYSTEM CALL FORWARDING

A central call forwarding system shall be programmed and activated. The call forwarding system shall support all standard types of call forwarding.

23.11 REMOTE – CONTROLLABLE NIGHT SERVICE

Subscribers with the appropriate authorization must be able to activate night service variants that have been set up both locally and on a network-wide basis.

23.12 ATTENDANT INTERCEPT WITH DIFFERENT CODE NUMBERS

It must be possible to specify 00 to 09 as intercept code numbers so that incoming exchange calls to tenant services for several users can be distinguished at the switchboard position or be appropriately distributed if several switchboard positions are involved. In conjunction with the intercept code number it shall be a possible to display a company name on the switchboard console.

In addition any other number out of the numbering scheme must be configurable, providing the specified functions.

23.13 CALL DATA REGISTRATION, EXTERNAL OUTGOING / INCOMING

The system shall store a call data record (CDR) for each connection so that it is possible to assign charges for outgoing exchange calls to the originator. The CDR shall contain at least the following data:

- Calling party number
- External destination number
- Date

- Day of the year
- Time at which call starts
- Call duration
- Call charge units
- Costs indicated on the display
- Serial number of the CDR
- Number of the trunk circuit

The CDRs stored on the system can be called and processed by the analysis unit.

23.14 CALL DATA REGISTRATION, NETWORK – WIDE

It shall be possible to store call charge data records for calls within the network so that telephone system costs within the network can be assigned to the originating parties. When the data records stored on the system have been processed by the analysis program, it is possible to apportion the costs for the operation of the telephone system equitably.

23.15 VOLUME CONTROL FOR VOICE SERVICE

Because of the combined use of analog, digital and IP telephones, and because of the use of analog and digital lines in the connection paths, the volume may vary considerably from call to call. No matter what the type of call, and under certain circumstances, the size of the network, approximately the same volume shall be ensured by connecting amplifying or attenuating networks on a call-by-call basis.

23.16 DIRECT DIAL UP TO TRUNK OR SUBSCRIBERS

This feature shall allow the direct dial to a terminal without been re-routing via system applications. The feature eases the manual hardware oriented (positional) dial up of analogue and CAS trunks, of B-channels in digital trunks as well as analogue ports. This shall allow faster diagnostics and access to ports with bottlenecks.

23.17 RECORDER ANNOUNCEMENTS

Connecting recorded announcement devices, it shall be possible to play appropriate texts to callers when certain switching states arise. The texts shall be played with the correct timing, i.e. from the beginning. It shall be possible to play back recorded announcements in the following situations:

- Required subscriber busy
- Required subscriber - no answer
- Redial request - destination busy
- Redial request - destination does not answer
- Company announcement and greeting text for calls to the switchboard position
- Waiting announcement for call to the switchboard position
- No immediate answer
- Waiting announcement for call to hunting group
- No immediate answer

It shall be possible to control the announcements individually via a connection matrix. A maximum of 64 different texts shall be available and it shall be possible to connect a recorded announcement simultaneously to up to 50 callers.

24.0 SUBSCRIBER FEATURES

24.1 STANDARD PACKAGE SUBSCRIBER FUNCTIONS

The features listed below are prerequisites for extension subscriber communication and basically shall be available to all analogue, digital or IP subscribers:

- Call forwarding with a fixed/variable destination
- Class of service switchover
- Direct call and direct call key function
- Add-on conference
- Multiple conferences with up to 8 participants
- Restriction of internal traffic
- Call interception
- Call transfer after answering
- Call transfer before answering
- Accept call
- Speed dialing – individual and system
- Toggling between two calls
- Consultation hold
- Call back - no answer
- Call back - busy

- Hunt group, linear
- Hunt group, cyclic
- Synchronized recorded announcement if not available
- Deadline set-up
- Relocation of terminals
- Saved number redial
- Station transfer security
- Day of the week, date and time in display
- PIN for personal identification
- Recall enable/block

24.2 ADD – ON CONFERENCE

Extension subscribers can add on a third subscriber to their conversation. The added-on subscriber can also be removed at any time. One or two external subscribers can be added on during an add-on conference.

24.3 MULTIPLE CONFERENCE

Digital extensions shall successively add on up to six further subscribers for the Hospital building, which shall also be external, to the original two participants. Every subscriber of a conference can act independently. The subscribers of the conference have the possibility to go on consultation hold or to do explicit call pickup to add a new subscriber to the conference as long as the maximum subscriber number is not reached yet. The conference can be put on hold to perform another function.

24.4 DIRECT CALLING

Pressing a button, subscribers with a digital or IP- telephone can call a programmed internal subscriber. The direct call is indicated to the called party by means of a special ringing signal. The direct call button has an LED which comes on when the direct call destination is busy. If the key is nevertheless pressed, the direct call destination is alerted by means of a call waiting signal. It shall be possible to set up a maximum of 30 direct call keys for a digital subscriber. If there are several subscribers it must be possible to set up one subscriber as a direct call destination.

24.5 TEAM CALL PICKUP

Subscribers in a pickup group can take calls for another team member at their own telephone. Analog, digital or IP- telephones can be included in a team.

24.6 DIRECTED CALL PICK UP

Directed call pick up of calls from other work points can be activated by either pressing the according function key or by dialing a prefix and the extension number.

24.7 CALL FORWARDING WITH VARIABLE DESTINATION

In addition to call forwarding with a fixed destination, the subscribers shall also have call forwarding with variable destination which they can program themselves.

24.8 CALL DEFLECTION

Subscriber shall have the possibility to call forward an incoming first or second call. The call shall be forwarded to the call forwarding ring now answer destination.

24.9 SUBSCRIBER CONTROL OF FORWARDING

Authorized subscribers shall have the possibility to override call forwarding at a called destination.

24.10 PARK TO SYSTEM

A station or an attendant user shall be able to place a trunk or station connection into a system park slot. Once parked the call shall be retrieved by the same station that parked the call or another station. After having parked the call the station or the attendant user can make another call.

24.11 SINGLE CLASS OF SERVICE SWITCHOVER

Each extension subscriber can be assigned two classes of service. The subscriber can toggle between the two classes of service himself, protected by a procedure.

24.12 CLASS OF SERVICE SWITCHOVER

Class of service for an extension group can be switched over on an individual basis from the switchboard position or at a certain time by the system.

24.13 SPEED DIALING – INDIVIDUAL

Extension subscribers shall have an individual call number memory for a max. of 30 internal or external destinations that are retrievable by pressing a function key. The destinations are entered and modified by the subscribers themselves. Manual suffix dialing after outcall must also be possible. It must be possible to set up the feature for all subscribers.

24.14 SPEED DIALING - SYSTEM

Extension subscribers and attendants shall have – by pressing a function key – access to a central call number memory which can be divided up into a max. of 16 speed calling lists. Each subscriber can be authorized to use two lists each of which contains up to 1000 destination numbers. Suffix dialing after outcall must be possible. All subscribers shall be able to use speed calling-system. Memory capacity: 16.000 destination numbers.

24.15 CHANGING OF CENTRAL SPEED DIALING ENTRIES

A user shall be able to carry out several functions with one central speed call. With this, the chaining contains a sequence of digits which are usually carried out on the keypad. Up to 10 system speed call entries can be chained together.

24.16 CALL INTERCEPTION

Authorized extension subscribers shall be able to register the call number of a caller. It must be possible to set up this feature so that all calls for the authorized subscribers are registered or only those calls marked with a code number by the subscriber. It must be possible to print out the call number of the caller in the case of internal calls, calls via dedicated connections with identification and ISDN exchange calls.

24.17 DISCONNECTION

Authorized extension subscribers and attendants shall be able to go beyond call waiting/busy override and disconnect a call, if a suitable signaling method is available on the previous call path. In the case of subscriber busy, the call can be disconnected to affect one's own further call set up and, if the dedicated connection trunk is busy, a connection can be disconnected.

24.18 PERSONAL IDENTIFICATION NUMBER

The PIN is used to identify the subscriber to the communications system at his own telephone or someone else's. The PIN number, which can have up to 12

digits, is entered manually or by inserting a chip card in the case of digital telephones with a card reader. If entry is made on one's own telephone, the individual class of service is switched over. If the entry is made on someone else's telephone, the person entering the PIN number can use it like his own telephone – this also includes the key assignment. Call charges that accrue at someone else's telephone are assigned to the call number of the person who has entered the PIN number.

24.19 PROJECT CODE NUMBER (PCN)

By manually entering a PCN, before or while an exchange connection is set up, subscribers shall be able to assign the call charges that accrue to a certain project. The PCN is included in the call charge data record of the call charge registration for the project-related billing procedure.

24.20 DESTINATION KEYS

Subscribers with digital or IP- feature telephones can dial a programmed internal or external destination by pressing a key. It shall be possible to set up destination keys for each telephone. Further destination keys can be supplied by means of an add-on device. The destinations can be stored and modified by the subscriber himself.

24.21 RELOCATION TERMINALS

It shall be possible to move digital telephones within the area covered by a system without any administrative procedures at the operating terminal. This shall be done by entering a logoff code and the PIN before unplugging. In the new room or area, the logon code and the PIN are entered after the device has been plugged in again. The terminal/device shall then operate as it did originally.

24.22 CALL WAITING – TERMINATING

Subscribers with digital or IP- telephones with display shall be able to override an ongoing call for a waiting call. In the busy state, the calls receive the call connect signal, the subscriber receives an alerting tone and the caller is shown on the display. Without terminating the existing call, it shall be possible to take the waiting call and toggle between the two calls. The caller shall hear a special free signal to be informed about his call waiting.

24.23 DEADLINE SET – UP

Extension subscribers can enter a deadline time on their telephone for the next 24 hours. The system shall then call them at this time. Subscribers with digital or IP telephones can enter several deadlines. If the deadline call is not acknowledged, it is repeated after 5 minutes. If there is again no acknowledgement, the deadline call is cleared.

24.24 CALL CHARGE DISPLAY OR ELAPSED TIME DISPLAY ON DIGITAL OR IP-PHONES

When a call that incurs charges is being made, the display on digital or IP telephones shall indicate the accruing charges, the charge units, or the elapsed time. Every subscriber shall be able to decide whether the accruing charges, the charge units, or the elapsed time is shown on the display. If there is simultaneous communication involving several charge incurring calls (consultation hold, conference) and the accruing charges are chosen, the sum of the charges is shown on the display.

25.0 INTERCOM FEATURE

25.1 VOICE CALLING

Subscribers with a digital or IP- telephone can voice call other digital subscribers if their phones are equipped with open listening and hands free talking without the called party needing to lift the handset. Subscribers can permanently or temporarily protect themselves from voice calling by means of an appropriate procedure.

25.2 HANDS FREE ANSWERING

If subscribers with a digital or IP- telephone are voice-called and their telephone is equipped with hands free talking, their microphone is turned on automatically to permit hands free answering.

25.3 SPEAKER CALL ONE – WAY

Subscribers shall be able to initiate a speaker call, which provides a one-way connection to a single destination of their choice.

25.4 COMMUNITY GROUP CALL

Subscribers with digital or IP- telephones of a defined communication group (max. 100 members) shall be able to call each other without dialing the full extension number, to establish a normal connection.

25.5 COMMUNITY GROUP SPEAKER CALL – TWO – WAY

Subscribers with digital or IP- telephones of a defined communication group (max. 100 members) shall be able to call other members of the same group directly by shortened dialing. Speaker and microphone of the subscriber shall – if available – be activated automatically.

25.6 SPEAKER CALL – ONE WAY – BROADCAST

Subscribers shall be able to initiate a speaker call with a one-way connection to multiple (max. 40) destinations, simultaneously. The speakers of the phones – if available – shall be activated automatically. The first user to answer the announcement via going off-hook, could converse to the announcer and all other speakers shall be deactivated.

25.7 CALL LOG

Call log has to be provided for subscribers with digital or IP- telephones. Both incoming calls and call attempts and outgoing and abandoned calls are entered in the call journal. The user can simply page through the list and use the entry to set up an outgoing call.

25.8 DATA SECURITY FOR DIGITAL OR IP – TELEPHONES

On leaving the workplace, it must be possible for the user to lock the telephone or feature functions and key data for dialing aids against unauthorized use.

25.9 DISPLAY TELEPHONE BOOK

Subscribers with a digital or IP- display telephone who do not have their own PC with ETB at the workplace shall be able to access a centrally maintained telephone book. The dialing pad or an add-on device with alpha keys is used to enter names. After a partial entry, names are shown on the display and it is possible to scroll backwards and forwards in the list. The call is set up by pressing a key. Other functions supply facilities like personal telephone books and call journals for each subscriber.

25.10 INTEGRAL TWO – WAY HANDS FREE INTERCOM SYSTEM FUNCTION

Subscribers with digital or IP- telephones can voice call other subscribers with digital telephones if their telephones are equipped with open listening and hands free talking; the called subscriber does not need to lift the handset. If the voice-called subscriber has hands free talking, he can reply directly via the integral microphone. It must be possible for subscribers to override voice calling temporarily or permanently by activating an appropriate function.

25.11 BUZZ

It shall be possible to alert (buzz) a predefined destination with key function by pressing the function key or by entering a code number. Voice communication shall not be provided. The number of the caller shall be shown on the display of the alerted person for a short time. Buzz shall interrupt any other alerting of the predefined destination for the length of the buzz.

26.0 CTI (COMPUTER TELEPHONY INTER – PHASE) APPLICATIONS

The offered system shall support Computer Supported Telephone Applications (CSTA) in order to facilitate integration of LAN and IVRS.

The offered system shall support CTI applications (Computer Telephony Integration) for features like Screen Popup through CLI or DNIS (Dialed Number Identification Service).

26.1 MOBILITY SOLUTIONS

The offered system shall support IP soft phones and integrated DECT solution and VoWLAN Systems.

The system shall be capable of integrating with captive and public paging systems.

26.2 DIAGNOSTIC AND MAINTENANCE FACILITY

The system shall have in built diagnostic features such as Isolation/detection of faulty line/junction and restoration of faulty lines/junctions after rectification.

The offered system shall have remote maintenance facility using dial up connection for remote maintenance with proper password protections. The EPABX shall have auto restart capability to automatically reload the system software after system power is restored to it.

27.0 POWER SUPPLY

Construction of Super Speciality Hospital for Govt. Rajaji Hospital at Madurai, Tamil Nadu

Power Consumption of the exchange at full traffic conditions shall be as low as possible. The system shall be able to take normal 230V AC Supply or shall also have the provision of working on DC Supply.

APPROVED MAKES:

- | | | |
|--|---|--|
| 1) EPABX | - | ALCATEL / AVAYA / CISCO / SIEMENS / NORTEL |
| 2) ANALOG PHONES | - | BEETEL / PANASONIC / SIEMENS / ALCATEL |
| 3) VOICE BOX – RJII | - | KRONE / TVS / FINOLEX |
| 3) MDF | - | KRONE |
| 4) IDF | - | KRONE |
| 5) 2 PAIR / 4 PAIR CABLE | - | DELTON / FINOLEX / RR CABLE |
| 6) 10 PAIR / 20 PAIR / 50 PAIR / 100 PAIR CABLES | - | DELTON / FINLOEX / RR CABLES |

SECTION X PUBLIC ADDRESS SYSTEM

1.0 SCOPE OF WORK

The scope of work under this head shall include designing supplying and installing of Public Address System. The work under this system shall consist of furnishing all materials, equipment's and appliances and labor necessary to install the said system, complete with Speakers, Amplifiers, Mike, Zone selection Panel for interfacing with other systems.

2.0 System Specifications

The Public Address System is designed to serve the dual purposes of making general announcement, playing music or to announce the fire tone under fire condition. These different signals are to be transmitted through the same set of speakers. Hence, different level of priorities shall be allotted to different signals. The music shall be with the least priority and fire tone having next priority and the emergency announcement having the highest priority level.

Public Addressing system shall comprise of:

1. Metal Cabinet Racks
2. Ceiling ring speakers
3. Ceiling ring speakers with volume control
4. Wall Mounted Speakers
5. Booster Amplifiers.
6. System Controller.
7. Routers

3.0 Speakers

3.1 Ceiling Mount type Speakers

The loudspeaker shall have built-in protection to ensure that, in the event of a fire, damage to the loudspeaker does not result in failure of the circuit to which it is connected. In this way, system integrity shall be maintained; ensuring loudspeakers in other areas can still be used to inform people of the situation. The speaker shall have ceramic terminal blocks, thermal fuse and heat-resistant, high temperature wiring.

The Ceiling speaker unit shall be a 6 W dual-cone loudspeaker with an integrated circular metal grille and 100 V matching transformer. The speaker cabinet shall be of neutral white color.

3.2 Wall Mounted Speakers

The Wall mounted speakers shall have built-in protection to ensure that, in the event of a fire, damage to the loudspeaker does not result in failure of the circuit to which it is connected. The 10 W bi-directional cabinet loudspeakers shall provide good speech intelligibility and background music reproduction in staircase area.

4.0 Booster Amplifiers

The amplifiers shall be protected against overload and short circuits. The amplifier shall have temperature-controlled fan to ensure high reliability at high output power and low acoustic noise at lower power output. Additionally, all booster amplifiers have an overheat protection circuit that switches off the power stage if the internal temperature reaches a critical limit due to poor ventilation or overload.

The amplifier shall have a balanced input and a loop-through connector for easy connection of multiple booster amplifiers to increase the available output power. The amplifiers shall have 70 V and 100 V outputs for constant voltage loudspeaker systems and a low impedance output for 8-Ohm loudspeaker loads.

5.0 Rack Assembly

Rack assembly is to stack the amplifiers, monitor module, DVR and others. This shall be factory pre-wired and shall have different channels for AC mains cable and Audio signal cables. The rack shall be provided with wheels for easy Movement/maintenance. One lockable rear door shall be provided. The rack assembly shall operate on 230 VAC.

6.0 System Controller

The System Controller is the heart of the PA system. The controller shall include full system supervision, loudspeaker line impedance supervision, a supervised emergency microphone on the front panel and a supervised message manager. The messages can be merged to allow even more flexible use of pre-recorded announcements and evacuation messages. The controller shall be used as a standalone system with up to 6 zones, or expanded to up to 60 zones using additional routers. Up to 8 call stations shall be connected.

Interconnections shall be made using standard RJ45 connectors and CAT5 cable. All booster amplifiers connected to system controller shall be supervised. The audio

output shall be of 100V, for full compatibility with the public address equipment and EVAC-compliant loudspeakers.

The controller shall have BGM source inputs and a mic /line input with configurable priority, speech filter, and phantom power. The priority levels shall be specified for microphone, call stations and trigger inputs for optimum system flexibility.

The 100 V-technique reduces line losses on longer distances and allows for easy parallel connection of multiple loudspeakers. All zones shall be individually selected from the front panel and the BGM output level in each zone shall be individually set. The BGM output shall be connected to the 70V line, thus it shall be possible to connect a total load of 480 Watts in a two-channel system combined with a 480 Watt booster.

The output of the booster shall also be available as a separate output on 100V and 70V. A separate 100 V Call Only output is provided for addressing an area where BGM is not required but where priority announcements are.

Configurable Volume Override output contacts shall be available for overriding local volume controls during priority calls.

7.0 Routers

The router is an expansion unit, which adds additional zones to the PA system. Router shall provide outputs and inputs for one or two boosters in a multi amplifier one- or two-channel system.

Router shall provide dual channel operation for calls and BGM. Also single channel operation shall be possible with only one booster.

The router shall have a set of relays for zone-switching the power amplifier output(s) to different loudspeaker groups. Each of the zones can be switched between the call channels, the BGM channel or off.

In order to get a message through although the local volume controls have been set to a low volume level for e.g. background music, volume override relay contacts shall be provided for each zone separately for overriding local loudspeaker volume controls.

Upon a call or an activated trigger input, these contacts shall get activated for the appropriate zones, together with an additional voltage free contact (Call Active) for control purposes.

7.1 Announcements

Announcements shall be made through the microphones and by selecting the required zones. Announcements shall be made in following modes:

1. Individual mode

2. All Call mode

In “All Call” mode, announcement can be made to all the speakers simultaneously. This is useful when any common message to be passed to all. In addition, this is more convenient and fast to address the people during emergencies.

7.2 System Interconnection

The speakers in each zone are connected in parallel and are connected to the relay and switching unit. The cables from each zone are separately routed and are terminated in the relay switching units

8.0 Cable

2-core 1 sq.mm Multi standard copper wires.

8.1 Testing and Commissioning

Entire PA system shall be tested to establish the following.

- i. Functionality of the PA system
- ii. Combined systems shall be tested for the overriding feature for prioritizing fire alarm and life safety requirements.
- iii. Acceptable audibility of the public address in all spaces and record sound pressure levels of the Public address Vis a Vis the ambient noise levels.

The Provision of speakers is proposed so as to cover the entire area uniformly to have better communication system in the Hospital.

9.00 ROUND METAL CEILING LOUDSPEAKER

9.1 Technical Specifications

Rated power, Watts	6
Transformer tapping's 100 volt line, Watts	6/3/1.5/0.75/0.25
Transformer Impedance, Ohms	1.67k/3.34k/6.67k/13.3k/40k
70.7 volt line, Watts	3/1.5/0.75/0.375/0.125
Driver impedance, Ohms	8
Effective frequency range, Hz (BS6840)	120-17,500
S.P.L. ,@ 1m,1watt, dB	90
S.P.L. ,@Full power/1m, dB	97
Dispersion at 1,000 Hz, Degrees	180
Directivity Q factor, 1k Hz	2.3
Dimensions front and depth, mm	181 x 70
Net weight, Kgs	0.77

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Colour / Finish	White, RAL9016
Material	Steel
Mounting	Snap-on, Metal clip x 2

10.0 TECHNICAL SPECIFICATIONS FOR AMPLIFIER

Model	SPA 1240
Output power RMS 1 kHz, 1% THD	240W
Distortion (THD) 1 kHz, 100V out (80% indicated power)	0.2%
Dynamics	> 90 db
Operating Frequency	32 Hz - 42 kHz
Voltage Gain 100V OUT	81 (38dB)
Input Sensitivity (V RMS)	+ 4 dB 1.23v
Subsonic Filter - 3db, nachylenie	32 Hz, 24 dB/oct
Indicators (LED)	Signal, clip, ready, protect
Regulators, switches Front Back	Signal, vol Priority, priority HPF 240 Hz priority mode (auto/manual)
Cooling	Automatic heat control forced-cooling (From front to back)
Protections	Limiter, subsonic, soft start temp,
Emergency Power	24V DC +/- 17% lub 14-20V AC
Power Supply	230V AC + 10% - 15%
Idle (230V AC)	<160mA
Supply current at 1/8 rated power, pink noise	1.1 A
Supply current at 1/3 rated power, pink noise	1.6A
Filter storage	20000 uF
Max. output voltage	120-130V
Max. power dissipation	600W
Sockets inputs outputs	Signal in, priority in priority, control
Slew rate 100V OUT, Rated impedance	25V / us

SECTION XI

SPECIFICATION AND CONDITION FOR ELECTRICAL & ALLIED SERVICES

1. The works will be executed to comply with the CPWD General Specifications for Electrical works Part-I Internal (2013), Part II External (1994) Part-IV, Substation (2013), Part-V Wet riser & Sprinkler Systems (2006) and with upto date amendments and to confirm to the Indian Electricity Act of rules, BIS & Direction of Engineer-in-charge.
2. In case of contradiction between schedule of work with its Additional Specification and the General Specification, the former shall prevail.
3. The work will be executed as per general arrangement drawing and detailed fabrication drawings duly approved by the Engineer-in-charge. The various items of equipment will be ordered only after the drawings are approved and quantities in detail of various items are ascertained as per actual requirements. Therefore the actual quantities / measurement will vary from the stipulated quantities, which are only estimate.
4. The contractor / agency to be engaged for the work will a specialized agency with suitable satisfaction past record in performance of similar work. The contractor / agency will engage suitable qualified / experienced / licensed engineering supervisor for the work and suitable skilled personnel with required license for doing the erection work. Required special tools to be operated in the execution of the job.
5. The work will be performed as per the day to day instruction and approval of the engineer-in-charge. All materials/ equipments will be used after taking approval of the Engineer-in-charge.
6. All the equipment will be duly inspected in the manufacturers works/ premises before dispatch to the site.
7. The rates are to be inclusive of all taxes, levies, insurance, freight and nothing additional will be paid as per clauses (commercial condition) of additional specification of CPWD specification.
8. The work will be executed as per the programme of the completion of the project, and as per detailed PERT chart to be approved by the Engineer-in-charge. The delivery & erection schedule of various materials / equipments will be as per approval of Engineer-in-charge.
9. The contractor is responsible for the entire job as per relevant CPWD specification. If any item is left out within the schedule of work but if it is considered essential for the completion of the job, the contractor has to carry out the items.
10. Payment Terms :-

As per clause 7 Of GCC

11. Inspection & Testing :

HT Panels, Transformers, Busducts, Rising Mains with accessories, MV panels and APFC panels will be inspected in the respective manufacturer works before dispatch and routine test as applicable BIs will be provided for each equipment. During the testing the Engineer-in-charge will ensure complies with the agreement conditions and approved drawings.

It is important that each equipment is to be tested fully before dispatch

12. Workmanship :

The entire Bus-trunking, Rising Main erection and installation work will be supervised by the Engineer deputed by the manufacturer. After completion of installation the testing will be done by the Engineer deputed by the manufacturer.

The scope of Bus-trunking / Rising main starting from transformer, LT panel, upto raising main tap off termination into the floor LT panel.

13. Guarantee :

On account of latest technology adopted for transformer, Bus-trunking / Rising main, and Capacitor panel, the guarantee period is two years (instead of one year), from the date of successful testing of this installation, for which suitable bank guarantee may be provided.

14. Approved equipments of materials to be used are as below (No other material will be allowed). Materials which are not covered in the list will be procured after getting approval from the Engineer-in-charge / as per the approval list of CPWD specifications.

15. The Contractor had to submit the necessary drawings and applications to get the approval from the Electrical Inspector / BESCOM authorities. Necessary liaison work with the competitive authorities for obtaining the HT service connection to the building.

16. DB, MCBs will be MCB factory manufactured.

17. Modular switch boxes : Same make as modular switch manufacturer.

18. Contractor can use the approved makes. The Engineer-in-charge will have discretion to specify any particular make if required.

Additional Specification for Transformer

Applicable Standard	-	IS1117 / IEC 60726
Type	-	Cast Resin Dry type
No load voltage ratio	-	11kV / 433volt
Vector group	-	Dyn 11
Tap changer	-	On load Tap auto change + RTCC + AVR
Tapping Range	-	+5% to -15% @ 1.25%
Temp rise	-	90° C above ambient 40C
Class of insulation	-	Class F
Insulation level		
kVP/kV rms		
HV	-	75 /28
LV	-	3

Fittings of Accessories

Sheet steel enclosure protection	-	IP 23
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HT side suitable for 3 x 240 sqmm 11kV cable termination

LT side suitable for 1600 Amp Bus-trunking termination

List of Fittings for DRY TYPE Transformer:

1. Base channel skid type suitable for mounting on floor or plinth
2. 4 Nos Bi-directional Rollers
3. 2 Nos Earthing terminals
4. Lifting lugs
5. Off circuit tapping links on HV side
6. Diagram & Rating plate
7. Paint shade Siemens grey
8. Sheet steel enclosure IP23 for protection
9. Limit switch on HT side doors of enclosure
10. Inspection cover for off circuit tap links.
11. One No winding temperature scanna (digital) with alarm /trip contacts for transformer.
12. One no RTD sensor per LV winding

Additional Specifications for Sandwich Type of Bus-trunking / Rising Main

Suitable for 3 Phase4 wire, 415 volts 50Hz Ac system

Standard for compliance will be IEC 60439/I & II and IS 8623 / I & II. Busbars will be of aluminium conductor 99.5% pure 19501 grade. Each busbar will be provided with four layers of insulation, innermost layer will be of glass-mica and outer layer of polyester. Type of insulation will be Class F. Busbars will be in Sandwich configuration and located inside GI enclosure provided with epoxy powder coating to shade RAL 7032. Maximum length of section will be restricted to 3 Mtrs. Connection between one section to adjacent section will be through Uniblock Joint system operated by single bolt. The Uniblock assembly will be removable as complete sub-assembly without disturbing the adjacent busbars of adjacement sections. Temperature rise inside the Busbars or at any point will be restricted to 55 °C at 40°C ambient while carrying full load. Short circuit withstand capacity of Busbars will be as mentioned in BOQ. Busduct will be connected to Transformer / DG set terminals through Adaptor Boxes with copper flexible connections. Busduct will be fixed in position by suitable supports.

For earthing copper conductor Busbars (2 Nos) will be provided outside the enclosure and riveted to it. Suitable bends will be provided to complete the layout as required. Sandwich type Busbars will also be used as Rising Mains having the same specifications as above. In addition at individual floors tap off points will be provided as required to tap off connection through drawout tap off boxes. At each floor spring hangers will be provided to support Bustrunking. Rising Main will be closed t top. At bottom the Rising Mains will be continued to connect them to LT panel through Adaptor boxes and flexibles. Tap off boxes will be of drawout type complete with TPN MCCB of required rating, 35kA breaking capacity. Door of Plug in box will be interlocked with operating handle of MCCB.

Degree of

- Bus-trunking IP55
Rising Main IP54

SECTION XII

LIST OF APPROVED MANUFACTURERS / AGENCIES

Services / Materials to be consumed in the work shall be of the following manufacturers / agencies. In case the required materials / services are not available or the materials / services available with the manufacturers / agencies mentioned below do not meet the specifications (decision of the E-in-C in this regard shall be final & binding), the contractor shall obtain materials / services from the manufacturers / agencies approved by the E-in-C in writing.

1. LIST OF APPROVED MAKES / AGENCIES FOR CIVIL & PLUMBING MATERIALS

SL. No.	Item	Make / Manufacture
1.	Cement	ACC, Cormandal, Ramco Chettinadu, Ultratech, India Cements
2.	Reinforcement Steel & Structural Steel.	SAIL, TISCO, IISCO, Vizag Ispat, Jindal,
3.	Ceramic Tiles	Kajaria , H&R Johnson Tiles.Somany
4.	Vetrified Tiles.	H&R Johnson Tiles, Nitco, Kajaria, Hindware
5.	Marble Mosaic Tiles.	Bharath Tiles & Marbles (P), Nitco, Nimco, M.P.I., Balaji, Ajantha.
6.	P.V.C. Flooring.	Bhor Industries Ltd.,I.C.L. (India) Ltd., Chemplast, Wavin (India).
7.	Aluminium Extruded Sections.	Jindal, Indal.
8.	Glass.	Modi, Saint Gobain
9.	Plywood (Commercial).	Sharon, Kitply, Century.
10.	Plywood (Waterproof).	Sharon, Kitply, Century .
11.	Flush Door Shutters.	Kutty Flush Shutters, Sharon,
12.	Laminated Board – Particle.	Novapan, Bhutan Board.
13.	M.S. Windows.	I.S.I. approved, Parry.
14.	Paints.	Asian paints, Berger, Shalimar, Jenson & Nicholson, I.C.I., British paints, Goodlass Nerolac, Garware.
15.	Cement Paints.	Snowcem, Jenson & Nicholson, Durocem, Surfaced.
16.	Hardware for Wooden Doors: (a). Hinges – (b).Tower Bolt Bracs – (c). Locks – (d). Mortice Lock -	GARG (IS Mark), Janata, Mukund, Jyothi.(non IS mark) PAG, Godrej. Godrej.
17.	Plastifelt Water Proofing.	BASF, FOSROC
18.	Sanitary Fittings & Fixtures.	Hindware, Roca , Cera Parryware,Jaguar
19.	Gun Metal Valves.	Leader Engineering Works, Bombay Metal

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		Co., Annapurna Metal Works, ISI approved.
20.	G.I. Pipes.	1. Indian Tube Co. with proof class of pipes Specification/ and grade. 2. Zenith. 3. Jindal. 4. Tata
21.	C.P. Fittings.	1. Jaguar 2. ROCA. 3. Marc 4. Hindware (Benelave)
22.	Water Proofing Compound.	FOSROC, BASF.
22.	Water Proofing Compound.	FOSROC, BASF.
23.	Aluminium.	1. Indian Aluminium Co. – INDAL. 2. Jindal.
24.	GI Fittings.	1. R.M. Engineering Works (P). Jullander. 2. Bombay Metal Co., Bombay. 3. Annapurna Metal Works, Calcutta.
25.	Cast Iron Pipes & Fittings.	1. I.S.I. Approved. 2. NECO.
26.	R.C.C. Pipes.	1. Indian Hume Pipe Co. 2. Spun Pipe Co., (P) Ltd.
27.	Roof Sheetting.	Ambient, Sai Agencies, Inter-arch, Lloyd's, Indal, Alfa Enterprises.
28.	Structural Glazing.	Nikitha, Citadel, Alcopanel, Silver Streak Fab.
29.	False Ceiling.	AMF, Armstrong
30	Structural Steel	SAIL, TISCO, IISCO, Vizag Ispat, Jindal
31	Floor Spring, Door Closure,	Dorma. Hardyn and Everest as approved by Engineer in Charge
32	Fire Resisting door and Frame.	Navair / Shakti – met Dor/Godrej
A	SANITARY FIXTURES	
1	Vitreous China Sanitary ware	Hindware / Roca / Cera/Parryware/ Jaguar
2	Seat Cover (Heavy Duty)	Hindware / Roca / Cera/Parryware/ Jaguar
3	Cistern & lid (Dual flush)	Hindware / Roca / Cera/Parryware/ Jaguar
4	Concealed Cisterns	Jaguar / Gaberat

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5	Stainless Steel Sink	ISI certified makes
6	Lab Sink	Hindware / Roca / Cera/Parryware/ Jaguar
7	Auto Urinal Flush System (power operated)	Hindware / Roca / Cera/Parryware/ Jaguar
8	Wash basin	Hindware / Roca / Cera/Parryware/ Jaguar
B	C.P FITTINGS	
9	Pillar tap	Jaguar / Roca / Marc/Hindware(Benelave)/
10	3 in 1 Exposed Bath Mixer	Jaquar / Roca / Marc/Hindware(Benelave)
11	Shower Rose	Jaquar / Roca / Marc/Hindware(Benelave)
12	Angle Valve	Jaquar / Roca / Marc/Hindware(Benelave)
13	Sink Cock (wall mounted)	Jaquar / Roca / Marc/Hindware(Benelave)
14	Sink mixer (wall mounted)	Jaquar / Roca / Marc/Hindware(Benelave)
15	Bib cock	Jaquar / Roca / Marc/Hindware(Benelave)
16	Basin Mixer	Jaquar / Roca / Marc/Hindware(Benelave)
17	Basin Mixer (Opel single liver surgical purpose)	Jaquar / Roca / Marc/Hindware(Benelave)
18	Health Faucets	Jaquar / Roca / Marc/Hindware(Benelave)
19	Bottle Trap	Jaquar / Roca / Marc/Hindware(Benelave)
20	32mm full thread waste coupler	Jaquar / Roca / Marc/Hindware(Benelave)
21	Toilet Paper Holder	Jaquar / Roca / Marc/Hindware(Benelave)
22	Shelves	Jaquar / Roca / Marc/Hindware(Benelave)
23	Towel Rail/Ring	Jaquar / Roca / Marc/Hindware(Benelave)
24	Liquid Soap Dispenser	Jaquar / Roca / Marc/Hindware(Benelave)
25	Towel Rack 24" long	Jaquar / Roca / Marc/Hindware(Benelave)
26	Grab bar 450mm long	Jaquar / Roca / Marc/Hindware(Benelave)
27	Double coat hook	Jaquar / Roca / Marc/Hindware(Benelave)
28	Tumbler holder	Jaquar / Roca / Marc/Hindware(Benelave)

2.0 LIST OF APPROVED MAKES FOR WATER TREATMENT PLANT

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The following are the approved makes for Mechanical equipment. Tenderer shall note that use of the equivalent make shall be subject to approval of the E-in-C.

SL.No	EQUIPMENT / ITEMS	APPROVED MAKES
1	Raw water pump set	Kishor, Grundfos, kirloskar, IIT Lowara
2	Pressure sand filter	Ion exchange, Thermax
3	Softener	Ion exchange, Thermax
4	Sodium hypochlorite dosing system	Ion exchange, Thermax
5	Drinking water pump set	Kishor, Grundfos, kirloskar, IIT Lowara
6	Drainage pump set	Kishor, Grundfos, kirloskar, IIT Lowara
7	Chain pulley block	Indef, Ardee, J.K. Morris

3.0 LIST OF APPROVED MAKES FOR SEWAGE TREATMENT PLANT

SL.No	EQUIPMENT / ITEMS	APPROVED MAKE
1	Raw sewage pumpset - submersible type	Kishor, Grundfos, Kirloskar, ITT Lowara
2	Air Blower	Kay International , Kamlesh
3	Sludge pump	Kishor, Grundfos, Kirloskar, ITT Lowara
4	Chain pulley block	Indef, ardee, J.K. Morris
5	Axial flow fan	GEC, ABB
6	Pressure sand filter	Ion exchange, Thermax
7	Activated carbon filter	Ion exchange, Thermax
8	Filter feed pump - submersible type	Kishor, Grundfos, Kirloskar, ITT Lowara
9	Reclaimed water pump - submersible type	Kishor, Grundfos, Kirloskar, ITT Lowara
10	Sodium hypochlorite dosing system	Ion exchange, Thermax

6. LIST OF APPROVED MAKES FOR FIRE HYDRANT SYSEM

S. No	Materials	Manufacturers / Agencies
1	Diesel Engine	Cummins/Kirloskar/Misthubishi
2	Fire Pumps	Kirloskar/Mather & Platt/Armstrong/Grandfoss
3	Electrical Motors	Kirloskar / Seimens
4	MS Pipes ('C' Class)	Tata /JINDAL/ Zenith
5	Butterfly Valves	Intervalve / Audco/ Leader
6	BALL VALVE (15-40 mm Dia)	RB/ITAP/Leader
7	Sluice Valves	Kirloskar/Kalpana/Leader
8	Non-Return Valve (Flap Type C I)	Intervalve/Audco/Advance
9	Hydrant Valves	Newage/Minimax/Peter Autokit

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10	Hose	Newage, Premier Extra, Padmini, Aqua Dura
11	Fire Extinguisher	Safex/Minimax/Peter Autokit
12	Pressure Guage	HD/Waree/H-GURU/Fiebig
13	Pressure Switch	Danfoss/Indfoss
14	Termination Lugs	Dowells/Usha
15	PVC insulated Copper Wires	FINOLEX/WINCAP/POLYCAB/RR
16	Cables	Universal/CCI/Gloster
17	SFU's/FSU's	GE/L&T/C&S
18	HRC Fuses	As SI no17
19	Over Load Relays	ABB/L&T/
20	Single Phase Preventer	L&T/ Minilac
21	Indicating Lamps & Push Buttons	L&T /Technic
22	Air Break Contractors	Seimens/L&T/ABB/BCH
23	Sprinkler Head	HD/Tyco/Reliable/Fireasfe
24	Sprinkler lcv	HD/Tyco/Viking/Reliable/Fireasfe/Wormacd
25	Gunmetal Branch Pipe	Newage/Minimax/WINCO/Kailash
26	Threaded pipe fittings	R Brand/Unik
27	Air Release Valve	Rb/Tbs/Cimbrio
28	First Aid Hose Reel Drum	Minimax/Newage
29	First Aid Hose pipe	Padmini/Swastik/Usha Fire
30	Suction Strainer	Grandprix /Jaypee/Kirloskar/Leader
31	Battery	Exide/Amco
32	Pipe Protection	Pipe Kote (4mm Thick)
33	Pipe Support	Hi-Tech /Fabricated As per Site Conditions
34	Nozzle	Newage/Winco/Kailash
35	Foot valve (Gunmetal)	Neta/Leader
36	Foot Valve (Cast iron)	Kirloskar
37	Sprinkler flexible hose	Any UL listed

7. LIST OF APPROVED MAKES FOR FIRE DETECTION SYSTEM

S. No	Materials	Manufacturers / Agencies
1	Addressable Smoke and Heat Detectors and Multi Criteria	Notifier/Edwards/Bosch/ Siemens
2	PVC Insulated Copper Cables	Finolex/Lapp/Belden/Havells
3	Addressable Panel	Edwards/Bosch Notifier/Honeywell/ Siemens
4	Duct Detectors/Manual Call Box/input Module/Control Module	Zicon, Firepro, Honeywell, Siemens, Schneider, Bosch
5	Strobe	System Sensor /UL listed
6	Conduit	BEC/Vimco

8. LIST OF APPROVED MAKES FOR BMS

1	DDC Controllers	Johnson, Honeywell
		Cylon
		Siemens
		Bluestar
2	Interfaces / Gateways / Network Controllers	Johnson, Honeywell
		Cylon
		Siemens
3	Operation Workstation	
a	Hardware	IBM
		HP
		Dell
b	Software	Johnson, , Honeywell
		Cylon
		Siemens
		Bluestar
4	Colour Inkjet Printer	Cannon / Epson / Hewlett Packard
5	Outside Temperatures & RH sensor	Johnson/ Sontay / Greystone/ Siemens/ Honeywell
6	Immersion Temperature	Johnson / Sontay / Greystone/Siemens Honeywell
7	Water Flow switch	Siemens/Johnson Honeywell
8	Water DP Switches	Sontay/Kele
9	Duct /Room Temperature	Johnson / Sontay / Greystone/Siemens Honeywell
10	Duct/Room RH Sensors	Johnson / Sontay / Greystone/Siemens Honeywell
11	Air/Water Pressure Sensors	Johnson / Sontay / Greystone/Siemens
12	Level Switches	Kele/Veksler/Fluitech/Minilec

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13	Air DP switches	Johnson / Sontay / Greystone/Siemens
14	Damper Actuator	Johnson /Siemens
15	Room Thermostat for FCU	Johnson /Siemens/Anchor
16	Cables	Teleflex/Finecore/Varsha
17	Variable Frequency Drive	Johnson /Siemens/Emerson
18	2-way Motorized Valve	Johnson / Sontay /Siemens
19	PVC Conduits	BEC/Precision

9. LIST OF APPROVED MAKES FOR EQUIPMENT & MATERIALS – HVAC

S. No	Details of Materials / Equipment	Manufacturer's Name
1.	Water Cooled Screw type Chiller	Blue Star, York , Hitachi, Trane, Carrier, Dunham Bush, Hanbell, McQuay, Voltas
2.	Water circulation Pumps (Monobloc/Back pull-out).	ITT Bell & Gossett, Armstrong , Grundfos
3.	Variable Frequency Drive system	ITT Bell & Gossett, Armstrong , Danfos
4.	Pressurized Expansion Tank and Air separator	ITT Bell & Gossett, Armstrong, Anergy
5.	Air Handling Unit	Blue Star, Carrier, Voltas, ETA Caryaie, Edgetech, Zeco
6.	Fan Coil Unit	Blue Star, York, Caryaie, Edgetech, Zeco, ETA
7.	Cooling Tower	Paharpur, Advance, Bell, Flow Tech, Mihir
8.	Centrifugal fans	Nikotra, Comfrei, Kruger
9.	Thermal Heat Recovery Wheel	ABB, Bry Air, Novelaire
10.	M.S. & GI Pipes.	Tata Steel, Jindal
11.	Balancing valves	TA Auto Flow, Advance, Navtech, Flowcon
12.	Ball valve (up to 30 mm)	Danfoss, RB, Sant, Rapid
13.	Butterfly valve	Intervlve, C&R, Audco, Econsto
14.	Check valve	Advance , Intervlve, Kirloskar, Econsto
15.	Pot / Y Strainer	Emerald , Samsung, Sant
16.	Pressure Gage	Fiebig, Wika, H Guru.

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17.	GI Sheets	Jindal/Tata
18.	Pre Fabricated Ducts	Zeco/Camduct/Rolastar/Western
19.	Ball valves (Fan Coil Units)	Rapid Control, Emerald, Castel
20.	Auto Air Vent Valve	Rapid Control, RB, Anergy
21.	Grille/diffuser	Caryaire, Ravistar, Air Master, Dynacraft, Air Breeze
22.	Fire Damper	Caryaire, Ravistar, Air Master, Dynacraft Air Breeze
23.	Nitrile Rubber Open/ Closed Cell Elastomeric Insulation with adhesive	Armacell - Armaflex, Eurobatex – Union Foam
24.	Fibreglass (Foil Faced)	UP Twiga, Owens Corning
25.	Expanded Polystyrene (TF Quality)	Beardsell, Qualty thermopack, Coolite
26.	PUF insulation	Beardsell, Lloyds, Shreeevenus
27.	Two way motorized valve for AHU & FCUs	Tour Andover , Johnson Control , Honeywell, Siemens
28.	Room Thermostat	Tour Andover , Johnson Control, Honeywell, Siemens
29.	Flow Switch	Honeywell, Siemens, Rapid Control
30.	Electric Motors	ABB, C&G, Siemens

10. LIST OF APPROVED MAKES		
SL NO	ITEM	MAKES
A. ELECTRICAL		
1	RMU UNIT	Alsthom, ABB, Megawin, Siemens, GE
2	HT CABLE	Universal, Gloster, Torrent, RPG, Polycab
3	HT / LT CABLE TERMINATION / JOINT	Raychem, M-seal, Birla-3M
4	11 KV VCB PANEL	ABB, GE, Siemens, Alsthom

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5	TRANSFORMER	Kirloskar, Crompton, Alsthom, ABB
6	BUS DUCT, RISING MAIN & ACCESSORIES	Schneider, L&T, Legrand, GE
7	DIESEL ENGINE	Cummins, Kirloskar, Catterpillar
8	ALTERNATOR	Stamford, Lerroy Somer, Kirloskar, BHEL
9	AIR CIRCUIT BREAKER	Siemens, L&T, Schneider, ABB, GE
10	MOULDED CASE CIRCUIT BREAKER	Siemens, L&T, Schneider, ABB, GE
11	CONTACTORS, SWITCH DISCONNECTOR UNIT, CHANGE OVER SWITCH	Siemens, L&T, Schneider, ABB, GE
12	INDICATION LAMP, SELECTOR SWITCH, PUSH BUTTON	Salzer, Kaycee, Technic, Vaishno, L&T
13	VOLTMETER, AMMETER, MULTI-FUNCTION METER	AE, Schneider, L&T, Secure
14	RELAYS	Schneider, L&T, Siemens, ABB, Beluk
15	CURRENT / POTENTIAL TRNSFORMER	Kappa, Pragathi, AE, Kalpa
16	CAPACITOR	Universal, Mehar, Shreem, L&T, Siemens, Epcos
17	VFD / SOFT STARTER	ABB, Schneider, Siemenrs, L&T
18	BATTERY & BATTERY CHARGER	AE, Amar Raja, Chhabhi, Exide, Panasonic, Tata Green
19	STREET LIGHT POLE	Crompton, Bajaj, Wipro, Philips, GE
20	XLPE/PVC LT CABLES	Universal, Gloster, Torrent, RPG, Polycab
21	CABLE GLANDS & LUGS	Comet, Dowells, Multi-pressing, Hex, Jainson
22	CABLE TRAY & ACCESSORIES	Profab, Patny, Indiana, Elcon

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23	PVC CONDUITS AND ACCESSORIES	Precision, Avon Plast, BEC, AKG
24	PVC WIRES - FRLS (COPPER)	Finolex, RR kable, Polycab, Havells
25	MODULAR SWITCHES & SOCKETS	Legrand (Arteor), MK (Blenze), Anchor (Woods), Panasonic (Vision).
26	INDUSTRIAL PLUG & SOCKET	Legrand, MK, Siemens, HPL
27	MCB DISTRIBUTION BOARDS	Legrand, Siemens, L&T, Schneider
28	MCB's, RCCB, ISOLATORS	Legrand, Siemens, L&T, Schneider
29	TELEPHONE CABLES & WIRES	Delton, Finolex, RR Kable, Lapp Kable.
30	LIGHT FIXTURES	Wipro, Philips, GE, Bajaj
31	CEILING, EXHAUST, WALL FAN	Crompton, Usha, Bajaj, Kaithan, Almonard
32	UPS	Emerson, Socomec, APC, Numeric, Liebert
33	SOLAR SYSTEM	Tata BP, Lanco, Approved vendor of MNRE
The list of approved makes (electrical) shall be applicable to all electrical items operating in Building works, STP, WTP, ETP, Fire fighting system, HVAC system, lift etc		
B. OTHER ELECTRICAL ITEM FOR STP		
1	MOTOR	Siemens, NGEF, Crompton, Bharat Bijlee
2	MAGNETIC FLOW METERS	Yokogawa, Blue star, Krohne marshall, Fisher Rosemount, Frehing
3	ULTRASONIC SENSORS	Vega (Contech India Ltd), Endress, Hauser
4	PH SENSOR & CONTROLLER	Fisher Rosemount, Endress, Hauser
C. CCTV		
1	CAMERA	Sony, Bosch, Pelco, GE, Siemens, Honeywell
2	DIGITAL VIDEO RECORDER	Sony, Bosch, Pelco, GE, Siemens, Honeywell

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3	MONITOR	Sony, LG, Samsung, Philips
4	CABLE	Teleflex, Varsha, Finecore, Finolex
D. EPBAX & TELEPHONE SYSTEM		
1	EPBAX	Siemens, Avaya, Alcatel, Cisco, Nortel
2	ANALOG PHONES	Beetel , Panasonic, Siemens, Alcatel, BPL
3	MDF / IDF	Krone
4	TELEPHONE PAIR CABLE	Delton, Finolex, RR kable, Havells
E. PA SYSTEM		
1	AMPLIFIER	Bosch, Philips, Siemens, Honeywell, JBL
2	SPEAKERS	Bosch, Philips, Siemens, Honeywell, JBL
3	ELEVATORS/ LIFTS	OTIS, SCHINDLER, KONE, MITSUBISHI