PROPOSED EXTERIOR RESTORATION AND INTERIOR UPGRADE WORKS FOR BOMBAY NATURAL HISTORY SOCIETY FORT, MUMBAI FORT, MUMBAI

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TENDER DOCUMENTS – VOL B

Architect
Abha Narain Lambah Associates
Conservation Architects & Historic Building Consultants
7th Floor, Saveria building, Opp Gurudwara, 4th 5th Cross road, Gazdar Scheme, Santacruz (W)
Mumbai 400 054.

Client
BNHS
Bombay Natural History Society
Hornbill House, Shahid Bhagat Singh Rd, opp. Lion Gate, Kala Ghoda, Fort, Mumbai, Maharashtra 400001
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Additional General Conditions and Specifications

Shuttering Requirement

1. Contractor must have shuttering and formwork of Marine Ply, Acrospan, Aluminum Formwork. The Maximum eight repetitions will be allowed for all types of wooden shuttering material. Contractor shall use adjustable metal props for supporting all R.C.C. elements. The formwork design shall be approved by the Architect / PMC In Charge/ Officer appointed by Architect - PMC - in - Charge before erection.

2. The contractor shall setup a material testing Laboratory at site with all necessary equipment.

3. For all concrete works Fully Automatic Micro processor based PLC with SCADA Enabled concrete Batch Mix Plant (Pan Mixer) of minimum 18 to 20 Cubic Metre per hour capacity of any standard company with appropriate number r and pumps with diesel or electric operated with minimum size of 150 litres automatic water measuring system and integral weigher Hydraulic/Pneumatic type. The Architect / PMC may at his discretion, allow in writing hand mixing of concrete for minor items where small quantities are involved but in that case the Contractor shall increase the cement content of the mixture by 10% without any extra cost.

4. The cement to be used in the various Items must be of Portland Pozzolana Cement grade and for the concrete work Fly Ash can be used at maximum 17% of total cementious content.

5. The Vertical Shaft Impact (VSI) crush sand to be used in various items shall be as per IS 383-1970, 2016. The crush sand must follow all the provisions of the relevant Codes and specifications of Vertical Shaft Impact Crusher Sand (VSI).

6. All the cementations work should be properly cured as per the requirement of the item.

7. The placement of the concrete and the shuttering shall be as per relevant I.S Codes.

8. The contractor should submit the system of quality control at the Autoclaved Aerated Concrete (AAC) Block / Fly ash Brick manufacturing unit.

9. The planning Architect / PMC at site must be well acquainted with MS Project software.

10. All the required equipment / connectivity/software/hardware should be supplied by the Contractor to his personnel at site. The system of software should be compatible with the, then PWD Software and interface.

11. The contractor shall coordinate with, local authority and shall appoint one liasoning officer for the routine interactions with various departments, among their team members.

Staff safety

1. While executing the work, necessary precautions regarding safety of labour, supervisory staff, public and traffic users shall be taken by the agency
according to rules and regulations specified by the Government of India, Government of Maharashtra and as directed by District Court, Mumbai.

2. Suitable scaffolds shall be provided for workmen for all works that cannot safely be done from the ground, or from solid construction except such short period works as can be done safely from ladders. When ladder is used an extra mazdoor shall be engaged to hold the ladder and if the ladder is used for carrying materials as well, suitable footholds and handholds shall be provided on the ladder and the ladder shall be given an inclination not steeper than 1 to 4 (1 horizontal and 4 vertical).

3. Scaffolding or staging more than 3.25 m. above the ground or floors, swing or suspended from an overhead support or erected with stationary support, shall have a guard rail properly attached, bolted, braced and otherwise assured at least 1 m. high above the floor or platform of such scaffolding or staging and extending along the entire length of the outside and ends thereof with only such openings as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure.

4. Working platform, gangways and stairways shall be so constructed that they do not sag unduly or is more than 3.25 m. above ground level or floor level, it shall be closely boarded, have adequate width and be suitably fenced as described in 2 above.

5. Every opening in floor of the building or in a working platform shall be provided with suitable protection to prevent fall of persons or materials by providing suitable fencing or railing with minimum height of 1 metre.

6. Safe means of access shall be provided to all working platform and other working places. Every ladder shall be securely fixed. No portable single ladder shall be over 9 m. in length, width between side rails in a rung ladder shall in no case be less than 30 cm. for ladders up to and including 3 m. in length. For longer ladders with width shall be increased at least 6 mm. for each additional 30 cm. of length. Uniform step spacing shall not exceed 30 cm.

7. Adequate precautions shall be taken to prevent danger from electrical equipments. No materials on any of the site shall be stacked or placed as to cause danger or inconvenience to any person or the public. The Contractor shall provide all necessary fencing and lights to protect public from accidents and shall be bound to bear expenses of defense of every suit, action or other proceedings at law that may be brought by any person for injury sustained owing to neglect of the above precaution and to pay any damages and costs which may be awarded in any such suit, action or proceeding to any such person or which may with the consent of the Contractor, to be paid to compromise any claim by any such person.

8. For the construction work of upper floors safety nets should be provided on the floor beneath it.

All the Staff, labour at site should be protected with the appropriate safety measures.

9. Contractor should use New centering material for all the concreting work with the maximum repetition shall not exceed 8 Numbers. At the same time the Centering material shall be got approved from the Architect / PMC -In-Charge PMC/ Officer appointed by Architect / PMC in advance.

10. Steel to be used shall be invariably from the integrated plant steel more specifically TATA, SAIL, JINDAL and the cement to be used shall be of ACC, ULTRATEK or equivalent Pozolana Portland Cement. Any imported material regarding steel,
cement will not be allowed.

11. For steel cutting, bending, shuttering and allied works specific location shall be earmarked at site. All the transportation vehicle shall be equipped with vehicle tracker. Proper care to be taken to avoid the corrosion of the steel at store / yard by applying cement slurry without claiming for any extra cost.
Contractor shall provide a mock up room at site.

12. While excavation care should be taken by the contractor regarding noise level at night. No excavation activity shall extend beyond 10 PM at night. Contractor should follow the traffic rules regarding the conveyance of material at night.

13. It is on the part of contractor to take necessary permission from the Traffic Police regarding the conveyance of material.

14. While conveyance of the material contractor shall observe that there should not be any inconvenience to the traffic and no material should drop on road.

Provide minimum level of sanitation/safety facilities for construction workers:

The contractor shall strictly follow the provisions contained in Clause-18 & its sub- clause; Clause-19 & its sub-clauses of GCC-2010 for providing basic amenities to the workers. The contractor shall ensure cleanliness of workplace with regard to the disposal of waste and efficient provide clean drinking water and latrines and urinals as per applicable standard. The contractor shall strictly follow the “CPWD SAFETY CODE” of GCC-2010.

The contractor shall comply with the National Building Code 2005 norms on construction safety for ensuring safety during construction. The National Building Code 2005 have provisions for clean and hygienic accommodation, toilet facilities, purified drinking water, general store, a subsidized canteen, medical facilities, day care centre and onsite safety equipments, etc.

The contractor shall adopt additional best practices and prescribed norms as in NBC 2005.

The contractor shall submit sufficient documentary & photographic evidences in compliance to above three paras.

Reduce air pollution during construction:

The contractor shall ensure proper screening, covering stockpiles, covering brick and loads of dusty materials, wheel-washing facility and water spraying facility to reduce air pollution during construction. The site roads should be regularly sprayed with water and wheels of all vehicles should be washed to prevent air pollution. The contractor shall transfer, handle / store dry loose materials such as bulk cement and dry pulverized flay ash inside a totally enclosed system.

The contractor shall install dust screen (at least 3 M high) around the disturbed area to prevent air pollution and spillage to undisturbed site area.

The contractor shall undertake the responsibility to prevent air pollution (dust & smoke), ensure availability of adequate water supply for dust suppression, devise methodology to minimize impact of dust on the surrounding environment and ensure that these methods are implemented. The contractor shall provide
documentary evidence regarding the method of working, plant equipment and air-pollution-control system being adopted on the site.

The contractor shall efficiently use the natural resources (water, energy & materials) and takes measures to conserve the natural resources.

**Efficient water use during construction:**

The contractor shall prevent wastage of water during curing. The contractor shall also make efforts to minimize use of potable water during construction by proper & efficient construction water management on site.

The contractor shall construct Sedimentation tank for collecting of excess curing.

**Utilization of Fly Ash in building Construction:** The PPC cement to be used in the construction shall be as per conditional stipulated in the Additional Conditions of the NIT under the heading Technical Specifications. The PPC cement shall have fly ash content of maximum 17% of fly ash in each bag of cement duly supported by test results from the supplier.

**Minimize ozone depleting substances:**

The contractor shall employ 100% zero ODP (ozone depletion potential), HCFC (hydro-chloro-fluorocarbon) free and CFC (chloro-fluorocarbon) free insulation such as HCFC free rigid form insulation, mineral fibre cellulose insulation, glass fibre, wood fibre board, cork wool, expanded (bead) polystyrene, recycled newspaper and jute & cotton duly approved by Architect / PMC. The contractor shall not use materials which are not inherently zero-ODP such as polyurethane foams and polyisocyanurates. The contractor shall also submit certificates & vouchers from suppliers/manufacturers that the insulation used are ODP/CFC/HCFC free.

**Ensure water quality:**

The contractor shall ensure that water used in construction meets the water quality norms as prescribed in the Indian Standards for various applications. The contractor shall get the water tested with regard to its suitability of use in the works and get written approval from the Architect - PMC before he proceeds with the use of same of execution of works. If the water is not suitable, the contractor shall arrange Municipal water or from any other sources at his own cost and nothing extra shall be paid to the contractor on this account. The water shall be got tested at frequency specified in latest CPWD specifications/BIS code.

**PRESERVATION OF EXISTING TREES.**

It is obligatory on the part of Contractor to take utmost care to preserve the existing trees as it is and in no case contractor shall be allowed to cut the existing trees or the branches
there of, without written permission of the Architect - PMC and the competent authority. The Existing trees shall be protected by erecting 1.2 m high temporary half brick partition wall in the form of tree guard, at no extra cost.

Entry and exit of the construction vehicle shall be properly maintain by merging in and diverging out so as to avoid the accidents.

The contractor shall display the board at site showing the name of work, Project cost, Project duration, Name of contractor etc. as directed by Architect - PMC.

Contractor shall be fully responsible for any mishaps / accidents during construction at the time of construction. He should make all necessary safety arrangements to ensure safety of existing building users. He should get necessary insurance cover. Offer of contractor shall be inclusive of all costs for making such insurance cover and safety arrangements. He shall not be paid separately for making such necessary arrangements.

Any damages to the existing structure shall be made good by the contractor at his cost, as per the instructions of Architect / PMC in charge. He shall not be paid separately for making such necessary repairs to damages. Offer of contractor shall be inclusive of all costs for making such necessary repairs.

The contractor should make adequate provision and make preventive arrangement to avoid dust and noise pollution in the premises at his own cost.

Contractor shall cover the entire premises and work by providing with precoated G.I. Sheets of height 3.00 metre and above with necessary support system etc. at his own cost and as directed by Architect / PMC.

The contractor shall co-ordinate with the private liasoning Architect appointed for the work of Green Building concept and shall appoint one liasoning personal for the routine interactions with him/her among the team members.

All flow and flush system and fixtures to be of Low Flow, as per specification drawing attached.
1. CONSERVATION SPECIFICATIONS

1.1 DISMANTLING, DEMOLITION AND REMOVAL
As this is a prime Heritage Building, Contractors shall take all precautions to see that any dismantling, demolition work is done in such a sequence and manner as to prevent all damage to usable and any damage to nearby property or injury to life. To this effect the Contractor may be required to erect suitable barricades around the works as directed for which no claims for extra payment will be allowed.

A register shall be opened by the contractor on the work site to show a day-to-day account of the turnout of salvaged materials. This register should also show whether dismantled material is properly stacked or wasted. It shall be signed by the representative of the contractor and by the Engineer-in-charge on site.

Any part of the indicated structure shall be dismantled carefully, and the materials removed without causing damage to the serviceable materials and the part of the structure to be retained, and any properties or structure nearby. Any damage to nearby property or structure shall be made good by the contractor without extra claims. The contractor shall be responsible for any injury to the workers or the public. Removal of overlaying adjacent materials if required for dismantling of the structure, shall be included in the item.

Before demolishing any part of the structure, the contractor shall provide supports and struts to the existing structure as and when directed by the Consultants. All struts and support shall not be removed by the contractor until written permission is obtained from the architect or structural engineer. No extra claims for such skirting or supports shall be paid for, it shall be included in the tender under respective items for demolishing. All scaffolding will be in steel and will have rubber ends, so as to not damage any part of the structure.

All the materials obtained from the removal of the structure shall be the property of the owner. Serviceable materials shall be stacked neatly in such a manner as to avoid deterioration and in places directed by the Consultant within a distance of 100m. Different categories of materials shall be stacked separately. Materials which are to be reused, shall be numbered before dismantling, carefully dismantled to avoid any damages and stacked in an order which facilitates the re-use.

Unless otherwise provided, excavated materials shall be used in back filling the excavation made in removing the structure, in leveling ground or otherwise disposed off, as directed free of cost. Serviceable materials may be issued to the contractor for use in the new work or elsewhere at the rates and as per conditions provided in the tender. No material shall be disposed off by the contractor without the specific instructions of the Consultants.

1.2 ENABLING WORKS – SCAFFOLDING, MOBILE WORK STATIONS & PROTECTIVE WORKS
NOTE: THE CONTRACTOR IS TO PROVIDE THE SCAFFOLDING AND ENABLING WORKS LISTED BELOW AS PER THE FOLLOWING SPECIFICATIONS TO BE INCLUDED
The contractors have to provide scaffolding for the external and internal works as per the schematic arrangement given by the Architect, based on which he shall prepare detailed fabrication drawings. The total quantity of scaffolding to be deployed at site with repetitive use should take into account the completion period of the work. However, sufficient
scaffolding material should be brought to site to cover a minimum of one third of the total work area.

Various precautions to protect the Heritage aspects of BNHS and finishes from damage as detailed herein shall be taken by the Contractor. The cost of scaffolding and various protective measures have to be included in the rates quoted by the contractor. It should be clearly understood that no work will be allowed to be carried out without the approval of the Architect/Engineer for the scaffolding and other protective arrangement mentioned in these special specifications of work.

A safe, (largely free-standing) metal pipe scaffolding with clamp jointing shall be provided for the operation, with metal sheeting / timber plank and lifts at 8 feet heights. To ensure safety for inspection of the surfaces by the Site personnel and labour, stiffeners shall be provided at regular intervals, including sturdy metal ladders of the type which are pre-fitted into the scaffolding. The circular pipe sections shall have rubber inserts at the pipe ends at the point of contact with the stone surface, so as to avoid damage to the building. A tarpaulin covering shall be provided to ensure environmental protection and for technical reasons, to prevent inconsistent drying of surfaces during the process. Scaffolding permissions from the Municipal Authorities and the subsequent costs involved will be the responsibility of the Contractor.

The specifications for scaffolding are as follows:

Providing and erecting two legged metal tubular scaffolding, of width 1200 to 1500mm largely free standing, using H frames or tubular pipes of minimum 40 mm diameter, with base plates, fixed or adjustable with necessary clamps, couplers, brackets for projections, joint pins, pulleys and other accessories, including steel angle or tubular pipe bracings at adequate intervals, access platforms of metal or timber planks of span not exceeding 2.5 metres, including provision of rubber inserts to pipe ends at points of contact with structure to avoid damage, including access ladders with intermediate platforms. The scaffolding is to be suitably braced and anchored to the building using support systems created temporarily at the openings in the walls using vertical and horizontal adjustable steel props. The rate includes provision of high density plastic sheet covering to protect architectural details on the entire building face, required, and safety platforms at ground level covering the entrances to the building.

Note: It should be noted that where scaffolding is taken up over floors, adequate supports are to be provided from below the floors to take the load of the scaffolding.

a) Providing and erecting exterior scaffolding as above, including dismantling, shifting and re-erection. The minimum quantity of scaffolding to be deployed shall be at least one third of the total estimated measured area in elevation

b) Providing and erecting high density plastic sheet covering fixed to the exterior face of scaffolding including duck tape with safety signage “work in progress” and “caution” boards at ground level and demarcation of entrances to the building Conservation, Revitalization and Seismic Retrofitting

c) For interior of lobby providing and erecting internal scaffolding up to vaulted and domed ceiling soffit using two legged metal tubular arrangement as described in ENB/1 in rows spaced at a distance not exceeding 2.5 meters, including suitable cross and horizontal bracing in both planes to make the entire scaffolding erected over the floor as self supporting, space frame arrangement without anchorage from the building components.
The rate includes for providing planks below base plates of tubular scaffolding pipes. Minimum of one third of the quantity of the total measured area in elevation shall be deployed at site. The measurements will be calculated by multiplying the lengths of the two legged units at the centre line of the 1200-1500mm scaffold unit widths x heights of the individual rows. The rates will include for the cross bracings between the rows of the scaffold units. Where scaffolding is taken over upper floors or terrace these shall be adequately shored and supported from below.

d) **Supplying and providing mobile working platform fabricated with tubular pipes** of 50/40 mm dia. With solid rubber castor wheels and platforms for working at various heights, over all size of unit to be 5m long x 1.8m wide extendable up to 5m height complete with access stairs, safety railings etc. A minimum of two such mobile units will have to be deployed at site.

e) **Careful Packing of all sculpture details/ decorative grill work/ delicate tracery and statuary in bubble wrap plastic sheeting** with masking tape and duck tape to ensure absolutely no damage to the details during the site works.

f) **Plaster of Paris covering of 30mm thickness over the entire floor area** with a bottom layer of high density plastic sheet over Minton Tiles inside the Lobby and verandah areas to ensure that scaffolding/ movement of machine and tools do not damage the historic flooring.

g) **Providing and erecting a temporary partitions using 6 mm thick commercial plywood** of approved quality and make and with adequate supporting framework to make it largely free standing to provide protection from other works in progress. The partitions shall be such that they can be removed and reused at different locations without damaging the property. Item to include printed duck tape with safety signage and words “Site Works in Progress” and “Caution” printed to cordon off areas of work. Adequate site signage in bold printed signs should be placed as per Architect’s instructions for safety instructions. **Providing and fixing temporarily 4mm thick commercial plywood** protection to glazed panels and stained glass, to be removed from site after completion of all work.

**Note:** Unless the above enabling works are done and approved, the work of demolition/construction in the concerned areas cannot be started

### 1.3. REMOVAL OF BIOLOGICAL GROWTH

#### 1.3.1. Removal of Ficus Growth

Ficus plants grow out of joints in the masonry walls. As the root system embeds itself deep into the masonry they cause widening of cracks, and often-greater structural problems within the building.

The process of removal of such growth shall be as follows:

- The parasitic plant growth shall be physically pulled out and uprooted, or in case of a very sturdy growth, chopped off above the stone surface. This shall be done at the time of stone cleaning, when the scaffolding is in place, for those plants that are not easily accessible.
- **Injecting a suitable biocide**

Biocides that are least damaging to the adjoining stone masonry shall be used. Some recommended chemicals are as follows:

- **Active Ingredient**
  - MCPA Agrozxone/ Agritox/ Cornox
  - 2, 4-D + dicamba
  - 2, 4-D + dicamba + ioxynil
  - 2, 4-D + dichloroprop
  - 2, 4-D + mecrop
  - Glyphosate
Note: These are just some recommended chemicals and any suitable alternative may be suggested.

Application of paste on the cut stem and root of the ficus plant
After cutting out the ficus, to the stump of the plant may be applied, a paste of 1 part powdered “Hing” (asafoetida) and two parts slaked lime putty. This may be applied as a paste over 2–3 times and allowed to dry.

1.3.2. Removal Of Algae, Lichens And Other Biological Growth

Algae, lichen and other biological growth occur at places where there is moisture accumulation due to leakage, poor drainage and damaged plumbing. This shall be attended just prior to intensive stone cleaning at the same time that the scaffold, is erected for pointing and cleaning of the stone surface. The tasks shall be as follows:

Scraping of the surface
The microbiological growth shall be removed by spatula, knife blades or stiff bristles or non-ferrous soft wire brushes.

Chemical Application
A chemical solution of quaternary ammonium based biocide shall be applied to the surface, or could be sprayed on to the affected surface and left for a few days. Tributyl tin oxide is also a proven biocide. This shall be then followed by gentle scraping and stone cleaning. Branded chemicals such as “Fongifluid” or equivalents may be also used in 2 coats for biocide wash.

1.4 STONE CLEANING & POULTICING

Staining of the stone surface is visible on the stone chajjas, parapet and stone element used in the minarets. The general masonry stone throughout the building, is of granite nature and thus a hard-igneous stone type, durable and resistant to weathering. However, it is vulnerable to efflorescence and staining due to its proximity to the sea.

The salt problem needs to be addressed by de-salination the stone surface through poulticing and gentle surface cleaning. Mild water washing and misting technique could be tried as test patches to ascertain their efficacy for this particular case. It would also be wise to gently scrape off moss and lichen growth and pull out ficus plant growths.

However, care needs to be taken to ensure that the cleaning is not in any way causing damage or causing an abrasive effect.

1.5 RE-POINTING OF STONE MASONRY JOINTS

Repointing of masonry joints becomes critical in areas where seepage is attributed to deteriorated pointing. The original pointing mortar used is lime based and therefore care needs to be taken to ensure that all re-pointing is done strictly in lime. Portland cement pointing should be avoided for historic stone buildings as it is too hard, impervious and inelastic and thus transfers greater mechanical stresses onto the adjoining stone masonry. Moreover, it has low porosity and traps moisture and prevents evaporation. Consequently, it accentuates the problem of water seepage and rising damp. Cement is also prone to having soluble salts, which may lead to efflorescence and salt deposits on the stone. In specifying the kind of lime mortar mix to be used for pointing, care should be taken to ensure that the crushing strength of mortar is much lesser (generally a third) than that of the stone. The normal lime and sand mix advocated is in the range of 1:2 1/2 to 1:3 for this building, as it uses a strong granite stone. Certain pozzolanic additives may be added to help in the faster setting. However, test mixes may be made with alternatives like stone powder and colored sands in order to best match the color and texture of the pointing mortar, with that of the
stone. In any case, samples of existing mortar and pointing mixtures should be analyzed to ascertain their chemical composition.

1.6 RESTORATION OF DAMAGED MOULDINGS
The worst mutilation of decorative moulding and stringer courses in the building, is due to the insertion of plumbing pipes and ac ducts throughout the building. This scenario is seen where rain water down take pipes have been introduced breaking through the finely detailed fret work of the arches. The first step in addressing this issue, would be the removal of badly located plumbing and rain water down takes from the external facades. This would then ensure the removal of all redundant pipes and the defaced façade could then be restored. Similarly, the ducts/pipe lines that cut through the carved moulding should be removed altogether to expose the fine detailing as was originally intended in the construction. The moulding / glass could then, based on the extent of damage, be either repaired using dutchman’s repair techniques (by replacing in like stone/ brick), or alternatively, the profile could be built up with plastic repair.

1.7 REPAIR OF DAMAGED GLASS AND WINDOWS
The windows of a historic building are an important constituent of its architectural character. Their design, craftsmanship and other qualities make them worthy of preservation. Evaluating the significance of these windows and planning for their repair or replacement can be a complex process involving both objective and subjective considerations. In the case of the Victoria Public Hall, the fenestration pattern of its glass is directly connected to the architectural quality of the facades. It is recommended that before any detailed specifications and tender documents are drawn up for work on site, a more detailed examination of the condition is conducted, with individual condition drawings noting condition of paint, frame, stiles, rails, glazing, hardware and shutters.

Many factors such as moisture, vandalism, insect attack and lack of maintenance can contribute to glass decay, but moisture is the primary contributing factor in the decay of wooden windows. The deterioration of the putty, that is if it is cracked, loose or damaged, too has a direct bearing on the condition of the timber, as it allows water to penetrate into the wooden joints. The window repair should be divided into the categories of routine maintenance, splices and partial replacement repair and also, complete replacement in the same design. Broken and damaged windows require replacement with new wooden slats, conforming to the original design of timber louvers that is integral to the historic building. At other places, the timber windows have missing glass or timber shutter panels or even cases where the original louvered shutters are concealed behind an outer set of shutters. At many places, the decorative panel of stone and lime fretwork motifs within the windows has been damaged. To ensure that no pigeons enter the building, these are then covered up with a wire mesh that is wholly incongruous. These need to be carefully restored to the original design and material.

The restoration of the windows should begin with the replacement of all missing panels of glass, timber or louvres, as the case may be, in the same material and the original design. All electrical wires that are presently routed through the timber louvers should be better located and all wire mesh should be summarily removed. The damaged timber elements should be suitably repaired or replicated, as the case merits and all other timber should be smoothed with sandpaper and re-painted or re polished as decided. Missing hardware of the original brass fittings also needs to be taken into account in any restoration exercise since the
replacements should ideally conform to the original design, sizes and material. All modern replacement of hardware that do not conform to the original brass fittings and design, should be replaced with heavy duty brass hardware of the original design.

1.8 RESTORATION OF WALL FINISHES
Similarly, original wall finishes like lime-based washes, lime stucco/ art plaster and distempers have a tendency to be replaced over the years, with a range of oil-based finishes. In the interest of maintaining the ambience of the heritage structure, it is recommended to retain lime-based finishes as an integral palette of finishes in any future maintenance regimen. It is recommended to restore the interior ambience and yet not deviate too much from the original interior scheme of the building. Paint scraping to establish the historic color schemes, original finishes and floorings would help establish the future strategy for interventions. Over the years, resulting from a combination of inappropriate finishes introduced over a period of decades, various finishes have been damaged and require some restorative intervention. This includes the silver oil paint on the art plaster in the court halls.

1.9 SPECIFICATIONS FOR METAL WORK – CLEANING, COATINGS & PAINTS

Note for surface coating of cast iron/ decorative metal work
The preparation of a sound surface usually involves removal of old paint. Rust, loose mill scale and soluble corrosion salts from the surface. It may be considered that paint removal may reveal cracks, corrosion and casting defects that are not previously visible and allowances may be kept for dealing with this with minor in situ welding and repair. All paint that is loose, flaking or delaminated must be removed. Sound paint surfaces may be simply rubbed down and refinished with one or two suitable coats if directed by Architect. Only wet hand processes should be used because of the risk from dust from lead pigments. Rubbing down should remove residual gloss, surface deposits and blemishes. Chipped areas of paintwork can be similarly rubbed down, ensuring that the surface under the paint to which corrosion has spread is also cleaned. Locally damaged paint areas should receive a shallow feathered edge and new paint coatings should overlap at least 50 mm on to existing sound surrounding paint coatings, and must be compatible with the existing coatings.

De greasing
Any oil or grease should be removed by gentle scraping followed by warm water and non ionic detergent thoroughly rinsed off with water. Non caustic based degreasing agents are also available, although a wipe over with white spirit and a succession of clean swabs is also sufficient.

Mechanical Cleaning
Mechanical processes may involve rotary wire brushes. A marginal improvement with this can be achieved over manual processes. An oxyacetylene or oxy propane flame may be used to remove old rust marks and paints but must be handled very carefully so as to quickly go over the surface without overheating or causing fire threats, especially since the adjoining ceiling is in timber. The thermal differential caused by the flame torches results in the rust and loose mill scales to de laminate. As an alternative to flame torches, mechanical dry abrasive cleaning may be adopted under supervision by a trained conservator, using the right grits and supply of air pressure. Test
areas should be done to check the efficacy of this method before embarking on the entire surface. Start at a pressure of 40 Psi with a fine copper slag grit and never exceed 60-70 Psi. Wet abrasive cleaning is preferable to dry where lead based paints are to be removed. It is also useful in washing from the surface soluble iron salts such as chlorides and sulphates that form within the corrosion pits. Cleaning should be done with a nozzle which has independent control over air, water and abrasive particulates. This should be done with utmost care to prevent any leakages/ over wetting of surrounding areas.

Chemical Cleaning
Orthophosphoric acid is the basis of many rust remover solutions. Methylene chloride is also one such paint stripper for small areas and their residues removed with white spirit or water, as directed. Solutions which are described as neutral are based on a combination of acid and alkali materials. Though best results are obtained by immersion, application may be tried out in trials. Rust convertors may be applied to sections that indicate symptoms of rusting. Acid pickling
In case of an entire panel being carefully removed, it may be immersed in a bath of a suitable acid (normally warm dilute sulphuric acid or phosphoric acid with adequate health and safety precautions) which dissolves mill scale and rust. On removal from the bath, the iron must be thoroughly rinsed with clean water.

Paint Coatings and Protective Primers
Primer
Red lead is traditionally used as a primer and though lead abatement is an increasing issue for health reasons, if applied with suitable precautions of masks, etc., toxicity can be kept to an acceptable level. Iron oxide is also a primer, with a minimum of 2 primer coats. Zinc rich coatings are considered among the best protective treatments. Zinc phosphate is a more recent and more used inhibiting pigment which is non toxic. A zinc dust primer may require a sealing coat and subsequent coatings need to be non saponifiable (non solvent in soaps) such as epoxies, chlorinated rubbers or vinyl paints. A second coat of primer rather than an extra finish coat increases the life of the paint system.

Binders
These are basic film forming materials. Paint binders may range from drying oil based (containing traditional raw, boiled or heat treated linseed oils dried by oxidation with air). These include alkyd resin paints; polymers such as chlorinated rubber and vinyl in solvent or what is most advisable, two pack epoxy and polyurethane coatings for corrosive environments. The performance of the drying oil can be improved by using micaceous iron oxide (MIO) pigmentation in undercoats and finishes (not in the primer).

Methods of Applying Paint
Brush application is the traditional method of applying paint and results in good adhesion of the dry paint film. Before painting, the metal surface should be free of dust, dirt or debris. Lead based paint should be applied by brush. One pack and two pack chemical resistant binders are however not suited to brush application. Paints should never be applied to damp surfaces, unless manufacturer’s specifications recommend that. For a good protection, a paint system should provide a total film thickness of 125 microns to 250 microns. This normally means at least four coats of air drying paint. 2 coats of primer are recommended. Final protective coatings over painted surfaces may include beeswax or varnish/shellac.
**Pigments**

Pigments are used to make the paint opaque and to give it a coloration. White lead, a whitish corrosion product of lead, was historically used as a hiding pigment. Since the early 20th century, Titanium oxide was introduced. Zinc oxide was used briefly in after 1850 and may be employed for this heritage structure.

Tinting pigments include earth pigments (ochres, siennas, umbers from iron oxide, greens from copper compounds and a few synthesized colourants such as Prussian blue or mercuric sulfide (crimson).
2. SPECIFICATIONS FOR STRUCTURAL WORKS

2.1 SPECIAL SPECIFICATIONS & SEQUENCE OF OPERATIONS FOR POLYMER AIDED STRUCTURAL REPAIRS

1. Provide adequate supports to the slab around the columns and beams with props and wooden runners to relieve the load on the structural members before cutting open the loose concrete to expose the steel reinforcement.

2. Clean the reinforcements thoroughly by wire brushes and tapping and remove all rust flakes and powder by dry dusting. Apply a coat of RUSTICIDE with a swab or small brush, and dust off after complete drying and hardening of the coat to render the surface of steel passive.

3. Completely clean the concrete surface after cutting to proper level, with blower, clean the reinforcement of all dust and apply Polymeric protective coat of Acrylic Polymer Latex in proportion 1:1.5 (Polymer : Portland Cement by weight), and allow to dry completely.

4. Additional rings are to be added to columns where corroded and to beams at the two ends by cutting grooves and anchoring from 50mm below the slab soffit upto L/4 of the span on either side. The anchoring is done by drilling holes in the concrete and sealing with Polymer : Cement grout, the bent steel hook at the top of the U shaped stirrup. Additional main steel can be added to the columns or beams within the rings. Also shear connector bars are to be fixed in to the structural member such as columns by drilling holes and fixing the shear connector bar in to the concrete bonded with epoxy or polymer formulation.

5. Apply Polymer modified cementitious mortar by hand and trowel with Acrylic Polymer Latex : Portland Cement : Graded Coarse and fine Quartz Sand in proportion 1:5:15 by weight of each constituent, over bonding coat slurry of 1:1 Acrylic Polymer Latex : Cement by weight, brushed on to the concrete surface and between layers of mortar, to build up the column and beam section to original size, and finished smooth in final layer to line & plumb. Records of weight of all constituents used in different batches should be recorded in site log book with time batch number etc. The mixing of the mortar and bonding coat to be done in plastic trays of adequate size, but each batch should not exceed 21 Kgs. Precautions are to be taken to see that the applicators and batch mixing labour should wear rubber handgloves, goggles & masks. For mixing the mortar about 1 to1.5 litres water should suffice to make a highly plastic mix, which should form a ball without disintegrating.

6. For building up cover concrete of the beams, a floating shuttering arrangement over adjustable props has to be provided, with the bottom plank covered with plastic sheet, kept 10mm below the original beam soffit level. The structural Polymer Mortar is pushed inwards over the plank from two sides of the beam bottom and packed properly after applying bonding coat to the cut concrete surface till the entire section is built up. After about 10 to 15 minutes the bottom shuttering plank is jacked up by 10mm by operating the adjustable props below the shuttering, which is brought to proper line and level with a string tied for perfect alignment of the bottom. The sides of the beam, which have been cut are brought to original size with, Polymer mortar and finished, as described in para 5. The bottom shuttering can be lowered after 24 hours.

7. The Polymer mortar repaired surface is to be air cured for 24 hours and then cured with water mist spray for 7 days.

8. Specially trained and experienced labour and supervisor are necessary for the above operations – which will be ineffective if not batched, mixed or applied properly with care.

9. The brand of Polymer Latex and chemicals recommended shall be of standard manufacture, purchased preferably directly from manufacturers or their dealers, accompanied with test certificates showing minimum solid content of polymer as 40%.
NOTE:
- Provide 6mm HeliBar keeping 500mm on either sides of the crack as shown in the photograph.
- (Refer RD CS 13 & RD RW 03)
- Drill the HeliBar’s end into the neighbouring wall if there isn’t enough space to extend it at least 500mm beyond the crack. Dot in the ends of bars shows the extension of the bar further or around the corner.
- Repair both faces of the wall using these remedies.
- Fill the cracks using CrackBond TE.
- Fill the drilled ends of HeliBars using PolyPlus SF.
- This repair scheme is derived considering the ground is stable and no ongoing movement.
NOTE:
- Provide 6mm HeliBar keeping 500mm on either sides of the crack as shown in the photograph.
- (Refer RD CS 13 & RD RW 03)
- Drill the HeliBar’s end into the neighbouring wall if there isn’t enough space to extend it
- at least 500mm beyond the crack. Dot in the ends of bars shows the extension of the bar
- further or around the corner.
- Repair both faces of the wall using these remedies.
- Fill the cracks using CrackBond TE.
- Fill the drilled ends of HeliBars using PolyPlus SF.
- This repair scheme is derived considering the ground is stable and no ongoing movement.
NOTE:

- Provide 6mm HeliBar keeping 500mm on either sides of the crack as shown in the photograph.
- (Refer RD CS 13, RD CS 08 & RD RW 03)
- Drill the HeliBar’s end into the neighbouring wall if there isn’t enough space to extend it at least 500mm beyond the crack. Dot in the ends of bars shows the extension of the bar further or around the corner.
- As shown in the photo, provide an 8mm CemTie of the appropriate length in the bulged area.
- (Refer RD CS 07 & RD CS 11)
- Repair both faces of the wall using these remedies.
- Fill the cracks using CrackBond TE.
- Fill the drilled ends of HeliBars using PolyPlus SF.
- This repair scheme is derived considering the ground is stable and no ongoing movement.
NOTE:

- Provide 6mm HeliBar keeping 500mm on either sides of the crack as shown in the photograph. (Refer RD CS 13, RD CS 08 & RD RW 03)
- Drill the HeliBar's end into the neighbouring wall if there isn't enough space to extend it at least 500mm beyond the crack. Dot in the ends of bars shows the extension of the bar further or around the corner.
- As shown in the photo, provide an 8mm CemTie of the appropriate length across the crack. (Refer RD CS 07 & RD LR 10)
- Repair both faces of the wall using these remedies.
- Fill the cracks using CrackBond TE.
- Fill the drilled ends of HeliBars using PolyPlus SF.
- This repair scheme is derived considering the ground is stable and no ongoing movement.
NOTE:
- Provide 6mm HeliBar keeping 500mm on either sides of the crack as shown in the photograph. (Refer RD CS 13)
- Drill the HeliBar’s end into the neighbouring wall if there isn’t enough space to extend it at least 500mm beyond the crack. Dot in the ends of bars shows the extension of the bar further or around the corner.
- Repair both faces of the wall using these remedies.
- Fill the cracks using CrackBond TE.
- This repair scheme is derived considering the ground is stable and no ongoing movement.
Cross Stitching a Cracked Solid Wall using CemTies

**METHOD STATEMENT**

1. Mark positions for holes on the outer face of the wall.
2. Drill a 14mm clearance hole (16mm if the CemTie is longer than 450mm) at the required location and angle and to the specified depth.
3. Clean out ALL dust from the hole and thoroughly flush with water. Where the substrate is very porous flushing with water is inappropriate, use HeliPrimer WB. Ensure the hole is damp or primed prior to commencing step 8.
4. Attach the required length of CemTie pinning nozzle to the gun.
5. Mix HeliBond cementitious grout using a power mixer and load into the Helifix Pointing Gun HD.
6. Pump grout to fill the nozzle.
7. Wind the CemTie into the nozzle and ensure that it is fully covered in grout.
8. Insert the nozzle to the full depth of the drilled hole and pump the grout.
9. Make good all holes at the surface with matching mortar and make good the crack using an appropriate Helifix bonding agent depending on the width of the crack or leave ready for any decoration.
10. Clean tools with clean, fresh water.

**RECOMMENDED TOOLING**

For drilling: SDS Rotary hammer drill 650/700W
For mixing HeliBond: 3-jaw-chuck drill with mixing paddle
For insertion of the CemTies: Helifix Pointing Gun HD with pinning nozzle

**Specification Notes**

The following criteria are to be used unless specified otherwise:

A. CemTies are to be installed perpendicular to the direction of the plane of the crack (e.g., in the horizontal plane for vertical cracks and in the vertical plane for horizontal cracks).
B. CemTies are to start a minimum of 225mm away from the crack.
C. Depth of hole to be CemTie length +25mm.
D. Angle of drilling to be such that the CemTies will pass through the crack within the centre third of the wall.
E. CemTies are to start from alternate sides of the crack and to be at 225mm spacing measured along the length of the crack.
F. In hot conditions ensure the masonry is well wetted or primed to prevent premature drying of the HeliBond due to rapid de-watering. Ideally additional wetting of the hole, or priming with HeliPrimer WB, should be carried out just prior to inserting the CemTie.
G. Do not use HeliBond when the air temperature is +4°C and falling or apply over ice. In all instances the hole must be thoroughly damp or primed prior to injection of the HeliBond grout.

The above specification notes are for general guidance only and Helifix reserves the right to amend details/notes as necessary.

**GENERAL NOTES**

If your application differs from this repair detail or you require specific advice on your particular project, call the Helifix Technical Sales Team on 020 8735 5222. Our Technical Department can provide you with a full support service including:

- Advice, assistance and recommendations on all structural repair matters
- Devising and preparing complete repair proposals for specific situations
- An insurance-backed warranty via our Approved Installers scheme
Repair of a Crack Near a Corner in a Solid Wall using HeliBars

**METHOD STATEMENT**

1. Using a twin-bladed, diamond-tipped wall chaser with vacuum attachment, cut slots into the horizontal mortar joints to the specified depth and at the required vertical spacing. Ensure that NO mortar is left attached to the exposed brick surfaces in order to provide a good masonry/grout bond.

2. Remove ALL dust and mortar from the slots and thoroughly flush with water. Where the substrate is very porous or flushing with water is inappropriate, use HeliPrimer WB. Ensure the slot is damp or primed prior to commencing step 5.

3. Mix HeliBond cementitious grout using a power mixer and load into the Helifix Pointing Gun CS.

4. Fit the appropriate mortar nozzle.

5. Inject a bead of HeliBond grout, approx. 15mm deep, into the back of the slot.

6. Push the 6mm HeliBar into the grout to obtain good coverage.

7. Inject a second bead of HeliBond grout over the exposed HeliBar and iron it into the slot using a finger trowel. Inject additional HeliBond as necessary, leaving 10-15mm for new pointing.

8. The crack within the wall should be weather-proofed using an appropriate Helifix bonding agent e.g. HeliBond or CrackBond, depending on the width of the crack and the surface made good or left ready for any decoration.

9. Clean tools with clean, fresh water.

**N.B.** Pointing may be carried out as soon as is convenient after the HeliBond has started to gel.

**RECOMMENDED TOOLING**

- For cutting slots up to 40mm deep .................................................. Twin bladed cutter with vacuum attachment
- For mixing HeliBond ................................................................. 3-jaw-chuck drill with mixing paddle
- For injection of HeliBond into slots ........................................... Helifix Pointing Gun CS with mortar nozzle
- For smoothing pointing .......................................................... Standard finger trowel

**Specification Notes**

The following criteria are to be used unless specified otherwise:

- **A.** Depth of slot into the masonry to be 35mm to 40mm.
- **B.** Height of slot to be equal to full mortar joint height, with a minimum of 8mm. For thin mortar joint specifications refer to the Helifix Technical Dept.
- **C.** HeliBar to be long enough to extend a minimum of 500mm either side of the crack or 500mm beyond the outer cracks if two or more adjacent cracks are being stitched using one rod.
- **D.** Normal vertical spacing is 450mm (6 brick courses).
- **E.** Where a crack is less than 300mm from the end of a wall or an opening the HeliBar is to be continued for at least 100mm around the corner and bonded into the adjoining wall.
- **F.** In hot conditions ensure the masonry is well wetted or primed to prevent premature curing of the HeliBond due to rapid de-watering. Ideally additional wetting of the slot, or priming with HeliPrimer WB, should be carried out just prior to injecting the HeliBond grout.
- **G.** Do not use HeliBond when the air temperature is +4°C and falling or apply over ice. In all instances the slot must be thoroughly damp or primed prior to injection of the HeliBond grout.

The above specification notes are for general guidance only and Helifix reserves the right to amend details/notes as necessary.

**GENERAL NOTES**

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- Advice, assistance and recommendations on all structural repair matters
- Devising and preparing complete repair proposals for specific situations
- An insurance-backed warranty via our Approved Installers scheme
METHOD STATEMENT

1. Mark positions for holes on the outer face of the wall.
2. Drill a 16mm clearance hole through the outer wall to the required depth.
3. Clean out ALL dust from the hole and thoroughly flush with water. Where the substrate is very porous or flushing with water is inappropriate, use HeliPrimer WB. Ensure the hole is damp or primed prior to commencing step 8.
4. Attach the required length of CemTie pinning nozzle to the gun.
5. Mix HeliBond cementitious grout using a power mixer and load into the Helifix Pointing Gun HD.
6. Pump grout to fill the nozzle.
7. Wind the CemTie into the nozzle and ensure that it is fully covered in grout.
8. Insert the nozzle to the full depth of the drilled hole and pump the CemTie and grout.
9. Make good all holes at the surface with matching mortar and make good the crack using an appropriate Helifix bonding agent depending on the width of the crack or leave ready for any decoration.
10. Clean tools with clean, fresh water.

RECOMMENDED TOOLING

For drilling ..................................................... SDS rotary hammer drill 650-700w
For mixing HeliBond ................................. 3-jaw-chuck drill with mixing paddle
For insertion of the CemTies ...................... Helifix Pointing Gun HD with pinning nozzle

SPECIFICATION NOTES

- A. CemTies are to be installed at a vertical spacing of 450mm.
- B. CemTies are to extend at least 500mm past the crack.
- C. Depth of hole to be CemTie length +25mm.
- D. Ensure the CemTies are installed into solid stone and not the mortar joints or loose rubble within the wall.
- E. If cracking occurs on both elevations consider using HeliBar crack stitching around the corner. If CemTies have to be used, they should be staggered between each elevation.
- F. In hot conditions ensure the masonry is well wetted or primed to prevent premature drying of the HeliBond due to rapid de-watering. Ideally additional wetting of the hole, or priming with HeliPrimer WB, should be carried out just prior to inserting the CemTie.
- G. Do not use HeliBond when the air temperature is -4°C and failing or apply over ice. In all instances the hole must be thoroughly damp or primed prior to injection of the HeliBond grout.

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- Advice, assistance and recommendations on all structural repair matters
- Devising and preparing complete repair proposals for specific situations
- An insurance-backed warranty via our Approved Installers scheme
**METHOD STATEMENT**

1. Using a twin-bladed, diamond-tipped wall chaser with vacuum attachment, cut slots into the horizontal mortar joints to the specified depth and at the required vertical spacing. Ensure that NO mortar is left attached to the exposed brick surfaces in order to provide a good masonry/grout bond.

2. Remove ALL dust and mortar from the slots and thoroughly flush with water. Where the substrate is very porous or flushing with water is inappropriate, use HeliPrimer WB. Ensure the slot is damp or primed prior to commencing step 5.

3. Mix HeliBond cementitious grout using a power mixer and load into the Helifix Pointing Gun CS.

4. Fit the appropriate mortar nozzle.

5. Inject a bead of HeliBond grout, approx. 15mm deep, into the back of the slot.

6. Push the 6mm HeliBar into the grout to obtain good coverage.

7. Inject a second bead of HeliBond grout over the exposed HeliBar and iron it into the slot using a finger trowel. Inject additional HeliBond as necessary, leaving 10-15mm for new pointing.

8. The crack within the wall should be weather-proofed using an appropriate Helifix bonding agent e.g. HeliBond or CrackBond, depending on the width of the crack and the surface made good or left ready for any decoration.

9. Clean tools with clean, fresh water.

*N.B. Pointing may be carried out as soon as is convenient after the HeliBond has started to gel.*

**RECOMMENDED TOOLING**

- For cutting slots up to 40mm deep: Twin bladed cutter with vacuum attachment
- For mixing HeliBond: 3-jaw-chuck drill with mixing paddle
- For injection of HeliBond into slots: Helifix Pointing Gun CS with mortar nozzle
- For smoothing pointing: Standard finger trowel

**Specification Notes**

The following criteria are to be used unless specified otherwise:

A. Depth of slot into the masonry to be 35mm to 40mm.
B. Height of slot to be equal to full mortar joint height, with a minimum of 8mm. For thin mortar joint specifications refer to the Helifix Technical Dept.
C. HeliBar to be long enough to extend a minimum of 500mm either side of the crack or 500mm beyond the outer cracks if two or more adjacent cracks are being stitched using one rod.
D. Normal vertical spacing is 450mm (6 brick courses).
E. Where a crack is less than 500mm from the end of a wall or an opening the HeliBar is to be continued for at least 100mm around the corner and bonded into the adjoining wall or bent back and fixed into the reveal, avoiding any DPC membrane.
F. In hot conditions ensure the masonry is well wetted or primed to prevent premature curing of the HeliBond due to rapid de-watering. Ideally additional wetting of the slot, or priming with HeliPrimer WB, should be carried out just prior to injecting the HeliBond grout.
G. Do not use HeliBond when the air temperature is +4°C and falling or apply over ice. In all instances the slot must be thoroughly damp or primed prior to injection of the HeliBond grout.

The above specification notes are for general guidance only and Helifix reserves the right to amend details/notes as necessary.

**GENERAL NOTES**

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- Devising and preparing complete repair proposals for specific situations
- An insurance-backed warranty via our Approved Installers scheme
METHOD STATEMENT

1. Using a twin-bladed, diamond-tipped wall chaser and vacuum attachment followed by a hand or power chisel, cut slots into the horizontal mortar joints, to the specified depth and at the required vertical spacing. Use a power/hand chisel to continue slots up to the internal corner. Ensure that NO mortar is left attached to the exposed brick surfaces in order to provide a good masonry/grout bond.

2. Where the slot ends at an internal corner drill a clearance hole into the adjoining wall as shown. (14mm if using HeliBond grout – recommended; 10mm if using PolyPlus resin)

3. Remove ALL dust and mortar from the slots and holes and thoroughly flush with water. Where the substrate is very porous or flushing with water is inappropriate, use HeliPrimer WB. Ensure the slots and holes are damp or primed prior to commencing steps 6 and 7.

4. Cut the 6mm HeliBar to the required length and bend the end to fit to the full depth of the hole, then remove.

5. Mix HeliBond cementitious grout using a power mixer and load into the Helifix Pointing Gun CS.

6. Fill the hole with HeliBond grout using the pinning nozzle (PolyPlus resin may be used if preferred).

7. Inject a bead of HeliBond grout, approx. 15mm deep, into the back of the slot using the mortar nozzle.

8. Push the HeliBar into the grout to obtain good coverage.

9. Inject a second bead of HeliBond grout over the exposed HeliBar and iron it into the slot using a finger trowel. Inject additional HeliBond as necessary, leaving 10-15mm for new pointing.

10. Point up or fill the remaining slot, make good the crack and leave ready for any decoration.

11. Clean tools with clean, fresh water.

N.B. Pointing may be carried out as soon as is convenient after the HeliBond has started to gel.

RECOMMENDED TOOLING

For cutting slots up to 40mm deep ........................................ Twin bladed cutter with vacuum attachment

To achieve final depth of slot beyond 40mm ....................... Hand or power chisel

For drilling ........................................................................... SDS rotary hammer drill 650-700w

For mixing HeliBond ....................................................... 3-jaw-chuck drill with mixing paddle

For injection of HeliBond into slots ................................. Helifix Pointing Gun CS with mortar nozzle

For injection of HeliBond into holes ............................... Helifix Pointing Gun CS with pinning nozzle

For smoothing pointing ................................................. Standard finger trowel

Specification Notes

The following criteria are to be used unless specified otherwise:

A. Depth of slot into the masonry to be 25 to 35mm plus the thickness of any plaster.

B. Height of slot to be equal to full mortar joint height, with a minimum of 8mm. For thin mortar joint specifications refer to the Helifix Technical Dept.

C. HeliBar to be long enough to extend a minimum of 500mm either side of the crack or 500mm beyond the outer cracks if two or more adjacent cracks are being stitched using one rod.

D. Normal vertical spacing is 450mm.

E. In hot conditions ensure the masonry is well wetted or primed to prevent premature drying of the HeliBond due to rapid de-watering. Ideally additional wetting of the slot, or priming with HeliPrimer WB, should be carried out just prior to injecting the HeliBond grout.

F. Do not use HeliBond grout when the air temperature is +4°C and falling or apply over ice. In all instances the slot must be thoroughly damp or primed with HeliPrimer WB prior to injection of the HeliBond grout.

The above specification notes are for general guidance only and Helifix reserves the right to amend details/notes as necessary.

GENERAL NOTES

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- Devising and preparing complete repair proposals for specific situations
- An insurance-backed warranty via our Approved Installers scheme
HeliBar

Helical stainless steel reinforcing bar for masonry repair and strengthening in both remedial and new build situations

Applications

- Crack stitching
- Lintel repair and creation
- Forming deep masonry beams
- Horizontal structural restraint (when used with BowTie systems)
- Reconnecting separated walls
- Securing parapet walls
- Support existing masonry when creating new openings
- Creating movement joints
- Reinforcing new build masonry
- Seismic upgrades for existing masonry
- Repairing bridges, tunnels and arches

Features

- Austenitic stainless steel helical bars
- Combines great axial strength with flexibility
- Accommodates differential building movement
- No additional stresses introduced into structure
- Generates high tensile strength with mortar (new build only) or HeliBond grout
- Extremely economical compared with alternative methods
- May remove or reduce the need for mass underpinning
- Fully concealed once installed
- Avoids expensive taking down and rebuilding
- Minimal disruption to building’s fabric or occupants
- Spreads structural loads to avoid secondary cracking
- Reduces the potential for cracking in shrinkable materials

HeliBar is inserted into HeliBond grout within a cut slot

For full Product Information, Case Studies and downloadable Repair Details, giving specifications for many common structural faults, go to:

www.helifix.com/products/retrofit-products/helibar
**Installation Procedures**

1. HeliBar to be long enough to extend a minimum of 20" either side of the crack or 20" beyond the outer cracks if two or more adjacent cracks are being stitched using one rod.

2. Where a crack is less than 20” from the end of a wall or an opening, the HeliBar is to be continued for at least 8” around the corner and bonded into the adjoining wall or bent back and fixed into the reveal, avoiding any DPC.

3. For solid masonry in excess of 8\(\frac{1}{2}\)" thick and in a cavity wall where both wythes are cracked, the wall must be crack stitched on both sides.

4. If there is render/plaster, this thickness must be added to the depth of slot. Crack stitching must be installed in the masonry and never in the render.

5. Ensure the masonry is well wetted or primed to prevent premature drying of the HeliBond due to rapid de-watering, especially in hot conditions. Ideally additional wetting of the slot should be carried out 1 to 2 minutes prior to injecting the HeliBond grout.

6. Do not use HeliBond when the air temperature is 40°F and falling or apply over ice. In all instances the slot must be thoroughly damp or primed prior to injection of the HeliBond grout.

**Technical Specifications**

| Material: | Austenitic stainless steel Grade 304 or 316 |
| Diameter: | 4.5mm, 6mm, 8mm and 10mm |
| Tensile strength (6mm HeliBar): | 10kN |
| 0.2% Proof stress (6mm HeliBar): | 900 N/mm² (304) 840 N/mm² (316) |
| Standard lengths: | 1m, 1.5m & 2m – in packs of 10 |
| Width of slot: | Full height of bed joint (10mm in render/plaster) |
| Bonding agent: | HeliBond cementitious grout |

**Recommended Tooling**

- For cutting slot up to 40mm deep: Twin-bladed cutter with vacuum attachment or angle grinder or hammer and mortar chisel
- For mixing HeliBond grout: 3-jaw-chuck drill with mixing paddle
- For injection of HeliBond into slots: Helifix Pointing Gun CS with mortar nozzle
- For smoothing pointing: Standard finger trowel
- For inserting HeliBar: HeliBar Insertion Tool

**Slot Depth and Spacing**

<table>
<thead>
<tr>
<th>Single</th>
<th>Cavity wall</th>
<th>Solid Masonry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth of slot</td>
<td>Up to 4&quot;</td>
<td>4&quot; to 8(\frac{1}{2})&quot;</td>
</tr>
<tr>
<td>Vertical Spacing</td>
<td>1&quot; - 1(\frac{1}{2})&quot;</td>
<td>1&quot; - 1(\frac{1}{2})&quot;</td>
</tr>
<tr>
<td>On both sides</td>
<td>Every 4 - 6 courses, 12&quot; - 16&quot;</td>
<td></td>
</tr>
</tbody>
</table>
CemTie

A fully grouted remedial tie for stabilizing solid masonry

Applications

• Stabilizing solid or rubble filled walls
• Reinstating failed lintels (when combined with Helibeam techniques)
• Securing multi-layer brick rings in bridges, tunnels and arches
• Reconnecting separated internal and external building walls
• Securing delaminated masonry
• Repairing and securing cornices and decorative fascias
• Securing parapet walls and copings

Features

• Grade 304 or 316 stainless steel tie up to 1m long as standard
• Quick, easy, non-disruptive installation
• Tie and grout installed simultaneously
• Ideal for overhead installations
• Highly cost-effective masonry stabilization technique
• Much quicker and simpler than alternative methods
• Fully concealed for sympathetic repairs
• CemTie plus HeliBond grout produces great tensile strength
• Flexible to allow normal structural movements

For full Product Information, Case Studies and downloadable Repair Details, giving specifications for many common structural faults, go to:

/www.helifix.com/products/retrofit-products/cemtie/
Installation Procedures

1. Drill clearance hole to required diameter and depth and thoroughly clean and wet down with water.
2. Attach the required length of CemTie pinning nozzle to the gun (see diagrams A and B below).
3. Mix HeliBond cementitious grout using a power mixer and load into the Helifix Pointing Gun HD.
4. Pump grout to fill the nozzle.
5. Wind the CemTie into the nozzle and ensure that it is fully covered in grout.
6. Insert the nozzle to the end of the drilled hole and pump the grout until the CemTie is fully embedded.

Fitting the CemTie pinning nozzle

1. Loosen the locking screws device and slide off the far end of the pinning nozzle.
2. Insert the pinning nozzle tube through the cone (as in A) and secure the flared end into position at the bottom of the cone.
3. Replace the locking screws device and secure to both the pinning nozzle tube and the cone (as in B).

Note: CemTie pinning nozzles are available in 12.7mm and 15.0mm diameters and the length is made to suit the CemTie. The 12.7mm pinning nozzle fits the cone nozzle. The cone nozzle must be drilled out to accept the 15mm pinning nozzle.

Technical Specifications

| Material: | Austenitic stainless steel Grade 304 or 316 |
| Diameter: | 8mm and 10mm |
| Length to be used: | 50mm less than the materials being tied |
| Standard lengths: | 400mm, 500mm, 600mm, 700mm, 800mm, 900mm and 1000mm – in packs of 10 |
| Diameter of clearance hole: | 8mm tie: length up to 600mm – 16mm; length 600mm to 1m – 18mm; 10mm tie: 18mm |
| Depth of clearance hole: | Length of CemTie + 1” |
| Bonding agent: | HeliBond Cementitious Grout |
| HeliBond consumption: | In a 16mm diameter hole; 10 linear metres from one 3ltr HeliBond tub (subject to voiding) |
| | In a 18mm diameter hole; 7 linear metres from one 3ltr HeliBond tub (subject to voiding) |

RECOMMENDED TOOLING

For drilling: SDS rotary hammer drill
For mixing HeliBond: 3-jaw-chuck drill with mixing paddle
For insertion of the CemTies: Helifix Pointing Gun Kit HD with pinning nozzle

A division of HALFEN USA Inc. • P.O. Box 547 Converse, TX 78109 • inquiry@helifix.com Toll Free: 888-992-9989 • Fax: 877-683-4910
HeliBond

High performance, injectable, cementitious, non-shrink grout

Applications

• Used to bond HeliBars into masonry for crack stitching, lintel repair and creation, masonry beaming and CemTie installation
• For bonding metal components into masonry and concrete substrates

Features

• Non-shrink, non-gassing, thixotropic grout
• Flows easily under pressure to fill voids
• Rapidly develops compressive strength
• Cures to 45N/mm² (28 days at 20°C)
• Ready-to-mix components supplied in two-pack sets to reduce waste

Repairing brick arch lintels

Creating masonry beams

Crack stitching

Over 100 standard repair specifications are available online, covering all common structural faults.

For full Product Information, Case Studies and downloadable Repair Details go to:
www.helifix.co.uk/products/grouts-resins/helibond-grout
**Directions for use**

1. Empty the contents of the liquid pack into the pail
2. Add the contents of the powder pack
3. Stir thoroughly using a power-driven paddle mixer. Do not attempt to mix by hand as this will result in inadequate mixing
4. Check the piston is a snug fit in the cartridge and adjust in accordance with the pointing gun instructions. Load the mixture into the cartridge in the pointing gun immediately after agitating
5. Inject into the slot or hole in a continuous operation. Typical working life of the mixture in the pail is around 2 hours with re-agitation. The cartridge should be emptied within 5 minutes. If the injection process is interrupted for any reason, empty any cartridge contents back into the bucket and re-mix until it again reaches a smooth injectable consistency

**Note**

- If the pail is to be re-used ensure that it is completely clean before loading fresh material
- Pointing may be carried out as soon as the HeliBond has started to set
- After use, clean all tools, mixers and containers with clean, fresh water

For anchoring applications, a minimum clearance of 2mm all around the component will be adequate but should be increased to overcome drill wander in deeper holes, 500mm+, or to accommodate highly absorbent substrates. For Helifix bars and ties the following will generally apply.

<table>
<thead>
<tr>
<th>Bar Diameter</th>
<th>Slot width</th>
<th>Hole diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5mm</td>
<td>6-8mm</td>
<td>NA</td>
</tr>
<tr>
<td>6mm</td>
<td>8-12mm</td>
<td>10-12mm</td>
</tr>
<tr>
<td>8mm</td>
<td>12-14mm</td>
<td>14-18mm</td>
</tr>
<tr>
<td>10mm</td>
<td>14-16mm</td>
<td>16-18mm</td>
</tr>
<tr>
<td>12mm</td>
<td>16mm</td>
<td>NA</td>
</tr>
</tbody>
</table>

**Performance data**

| Compressive strength: (at 20°C) | 2 days – 15N/mm² |
|                                | 7 days – 25N/mm² |
|                                | 28 days – 45N/mm² |
| Pot life:                      | 2 hours at 20°C |
| Temperature conditions:        | To be stored, away from direct sunlight, at 5°C to 25°C and not to be used at temperatures below 5°C or if there is a danger of frost |
| Pail storage:                  | Pails to be stacked no more than four high |
| Shelf life:                    | 12 months under normal conditions |
| Pack size:                     | 3.0 litres and 4.5 litres |

**RECOMMENDED TOOLING**

- For mixing components: Power drill and paddle mixer
- For injection into slots: Helifix Pointing Gun Kit - CS
- For injection into holes: Helifix Pointing Gun kit - HD
- Also available with pneumatic power

**Health and safety**

HeliBond contains Portland Cement and is therefore alkaline when wet. Unnecessary skin contact should be avoided. In case of eye contact, the eye must be irrigated with gently running clean, fresh water and medical attention sought.

A separate Health & Safety Data sheet is available on request.

The Mille, 1000 Great West Road, Brentford, London TW8 9DW
Tel: 020 8735 5200  •  Fax: 020 8735 5201  •  email: info@helifix.co.uk

www.helifix.co.uk  February 2018
CrackBond TE
250ml cartridge

General purpose thixotropic epoxy resin

Applications
• For bonding cracked masonry, metal fixings and anchors

Features
• Non-shrink, medium viscosity, thixotropic epoxy
• Flows easily under pressure to fill voids, strengthen porous masonry and bond cracked masonry
• Fills cracks from 2mm-10mm wide
• Gels rapidly and cures within 24 hours
• Excellent structural bond with bricks, blocks, stone, concrete
• 250ml part-usuable cartridge

For full Product Information, Case Studies and downloadable Repair Details go to: www.helifix.co.uk/products/grouts-resins/crackbond-te-cartridge
**Directions for use**

**For crack injection**

1. Ensure the crack is dry and free from grease, oil, dust and other contaminants.
2. Any loose material must be blown out with clean, dry compressed air to ensure both the complete removal of all dust and other loose particles and the continuity of the injection path.
3. It is generally possible to extrude CrackBond TE directly into the open crack, without the need to seal the face and fix nipples, by drilling small holes at regular intervals, typically at 150mm centre spacing. Successful application into wider cracks is dependent upon factors such as the shape and dimensions of the crack, its orientation and the total volume of the material to be placed.
4. After the resin has been allowed to cure, any holes or voids should be made good.

**For bonding anchors**

1. Drill the hole to the correct diameter and depth using a rotary percussion drill.
2. Clean the hole using a stiff wire or nylon brush and clean compressed air or blow pump.
3. Once the hole is prepared, remove the screw cap from the cartridge.
4. Attach mixer nozzle, place in applicator gun and dispense the first part of the cartridge to waste until an even colour is achieved.
5. Insert the mixer nozzle to the far end of the hole and half fill hole (depending upon application). Withdraw nozzle as you fill the hole. For deep holes, extension tubing can be used.
6. Immediately insert the tie or fixing using a slight twisting motion.
7. Excess resin should be removed from the mouth of the hole before it sets.
8. Leave the fixing undisturbed until loading time has elapsed, then attach the fixture and tighten the nut.

**Performance Data**

<table>
<thead>
<tr>
<th>Setting Times</th>
<th>Temperature</th>
<th>Gel Time</th>
<th>Service Load Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5°C</td>
<td>150mins</td>
<td>24 hours</td>
</tr>
<tr>
<td></td>
<td>20°C</td>
<td>30mins</td>
<td>8 hours</td>
</tr>
<tr>
<td></td>
<td>30°C</td>
<td>15mins</td>
<td>4 hours</td>
</tr>
</tbody>
</table>

**Typical Performance**

12mm ø bolt, 110mm deep in 14mm ø hole 30/Nmm² concrete: Characteristic tensile load (N_{th}) 59.6kN

Storage conditions: Cool, dry, frost-free conditions away from direct sunlight

Storage temperature: 5°C to 20°C

Shelf life: 24 months under normal conditions

Cartridge size: 250ml

For Health & Safety information, call Helifix for the relevant Safety Data Sheet
PolyPlus SF

Styrene-free polyester resin

Applications

• For securing remedial wall ties, resin bonded anchors and threaded rods
• Used to secure RetroTie and ResiTie remedial wall ties

Features

• Two part nozzle-mixed resin for consistent quality
• User friendly styrene-free materials
• Clean and easy to use in all types of masonry
• Usable in a standard applicator gun
• 300ml part-usable cartridge

For full Product Information, Case Studies and downloadable Repair Details go to:

www.helifix.co.uk/products/grouts-resins/polyplus-sf-cartridge
**Directions for use as a Resin Anchor**

(See individual Product Sheets on RetroTie and ResiTie for these applications)

1. Drill the hole to the correct diameter and depth using a rotary percussion drill.
2. Clean the hole using a stiff wire or nylon brush and clean compressed air or blow pump.
3. Once the hole is prepared, remove the screw cap from the cartridge and cut the film to remove the metal clip.
4. Attach mixer nozzle, place in applicator gun and dispense the first part of the cartridge to waste until an even colour is achieved.

**Performance Data**

5. Insert the mixer nozzle to the far end of the hole and half fill hole (depending upon application). Withdraw nozzle as you fill the hole. For deep holes, extension tubing can be used.
6. Immediately insert the tie or fixing using a slight twisting motion.
7. Excess resin should be removed from the mouth of the hole before it sets.
8. Leave the fixing undisturbed until loading time has elapsed, then attach the fixture and tighten the nut.

---

**SETTING TIMES**

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Gel time</th>
<th>Service load time</th>
</tr>
</thead>
<tbody>
<tr>
<td>5°C</td>
<td>18mins</td>
<td>145mins</td>
</tr>
<tr>
<td>10°C</td>
<td>10mins</td>
<td>85mins</td>
</tr>
<tr>
<td>20°C</td>
<td>6mins</td>
<td>50mins</td>
</tr>
<tr>
<td>25°C</td>
<td>5mins</td>
<td>40mins</td>
</tr>
<tr>
<td>30°C</td>
<td>4mins</td>
<td>35mins</td>
</tr>
</tbody>
</table>

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**TYPICAL PERFORMANCE**

12mm ø bolt, 110mm deep in 14mm ø hole 30/Nmm² concrete: Characteristic tensile load \( (N_{\text{ek}}) \) 43.3kN

<table>
<thead>
<tr>
<th>Storage conditions:</th>
<th>Cool, dry, frost-free conditions away from direct sunlight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage temperature:</td>
<td>5°C to 20°C</td>
</tr>
</tbody>
</table>

**Shelf life:** 12 months under normal conditions

**Cartridge size:** 300ml

---

For full technical details and loading capacities, call Helifix for the relevant Technical Information

SheetFor Health & Safety information, call Helifix for the relevant Safety Data Sheet
SPECIFICATION FOR MATERIALS

1. SCOPE
This specification provides general requirements regarding quality, testing, handling, storing of materials required for civil construction.
All materials used in the construction shall conform to relevant Indian Standards or shall be of an approved quality equal to an approved sample manufactured by renowned concerns and shall bear prior approval of the Engineer.
If any material is found defective or of nonstandard quality, the responsibility of risk shall devolve on the Contractor who shall replace such material with material of approved quality at his own cost.

2. CEMENT
General
20 bags of cement shall be taken to weigh one tonne.
The cement used shall be ordinary, low heat portland cement to conform IS:269 / IS: 8112 / IS: 12269 depends upon their grade or portland pozzolana cement to IS:1489 or portland blast furnace slag cement to IS:455.
High alumina cement of approved specifications, when specified for use as a high alkali resisting cement, shall be used only in accordance with the manufacturer's recommendations and as directed by the Engineer. Its use shall conform to the relevant clause given for concrete in alkali soils and alkaline water in IS:456. It shall not be mixed with either of the other kinds of cement.
Samples shall be taken from time to time for tests at an approved laboratory.
Storage on the Site:
The cement shall be stored in suitable weather tight building and in such a manner as to permit easy access for proper inspection. The cement shall be stored in such a manner as to prevent deterioration due to moisture and to minimize warehouse deterioration. Cement of different type and brands shall be kept in separate storage/stacks. Not more than 12 bags shall be stacked in one stack.
All accepted cement stored on the site shall be arranged in batches with the dates of receipts marked prominently and used in the same order as received from the manufacturer. The Contractor shall maintain a cement register in which all entries shall be completed daily showing the quantities received, date of receipt, source of despatch, type of cement etc. and also the daily cement consumption on site. This register shall be accessible to the Engineer for his verification.
Rejection of Cement:
The Engineer may reject any cement which has deteriorated owing to inadequate protection from moisture or due to intrusion of foreign matter or other causes. Any cement which is considered defective by the Engineer shall not be used and shall be promptly removed from the site of work by the Contractor at his own cost. The Contractor shall bear and will not be entitled for any compensation.

3. AGGREGATES
General:
Coarse and fine aggregates shall conform in all respects to IS:383 - Specification for Coarse and Fine Aggregates from Natural Sources.
Aggregates shall be obtained from a source known to produce these satisfactory for concrete. Aggregates shall consist of naturally available sand and gravel or stone crushed or uncrushed or a combination thereof. They shall be chemically inert, hard, strong, dense, durable, clean and free from veins and adherent coatings and with permissible porosity. Flaky and elongated pieces shall not be used. Whenever required by the Engineer-in-Charge the aggregates shall be washed by the Contractor before use in the work.
The source of aggregates shall be approved by the Engineer and shall not be changed during the course of the job without his approval.
Deleterious Materials:
Aggregates shall not contain any harmful material, such as iron pyrites, coal, mica, shale or similar laminated material, clay, alkali, soft fragments, sea shells, organic impurities, etc., in such quantities as to affect the strength or durability of the concrete and in addition to the above, for reinforced concrete any material which might cause corrosion of the reinforcement. Aggregates which are chemically reactive with alkalis of cement shall not be used.
The maximum quantities of deleterious materials in the aggregate, as determined in accordance with IS:2386 (Part II) for method of Test for Aggregates for Concrete shall not exceed the limits given in Table-I of IS:383.
The sum of the percentages of all deleterious materials shall not exceed five. Deleterious materials also include material passing 75 micron IS sieve.
Coarse Aggregates:
Coarse aggregates is aggregate most of which is retained on 4.75 mm IS sieve. These may be obtained from crushed or uncrushed gravel or stone as per Cl.2.2 and may be supplied as single sized or graded aggregates as given in Table-2 of IS:383.
Fine Aggregates:
Fine aggregate is aggregate most of which passes 4.75 mm IS sieve, but not more than 10% pass through 150 micron IS sieve. These shall comply with the requirements of grading zones: I,II & III, as given in Table-4 of IS:383. Fine aggregate conforming to grading zone IV shall not be normally used in reinforced concrete unless tests have been made by the Contractor to ascertain the suitability of the proposed mix proportions and approved by the Engineer. The soluble contents shall not exceed 0.5%. Sand shall be suitable for attaining compaction of 90% of laboratory dry density.
Fine aggregates shall consist of natural sand resulting from natural disintegration of rock and which has been deposited by streams or glacial gencies, or crushed stone sand or crushed gravel sand. For concrete work the sand shall be coarser than that for masonry work.
Sampling and Testing:
In case of doubt the Engineer may require the Contractor to carry our tests, at the Contractor’s expense in accordance with:

IS:516 : Method of tests for strengths of concrete
and
IS:2386 : Method of tests for aggregates for concrete.

Storage of Aggregates:
The Contractor shall at all times maintain at the site work such quantities of aggregate as are considered by the Engineer-in-Charge to be sufficient to ensure continuity of work.
Each type and grade of aggregate shall be stored separately on hard firm ground having sufficient slope to provide adequate drainage to rain water.
Aggregate becoming wet at site due to rains etc. or delivered at site in wet condition shall be subjected to drainage for at least 24 hours before putting it to use.

4. SAND FOR FILLING
Sand for filling shall be medium hard, strong, free from organic and deleterious materials from an approved source.

5. WATER
Water shall be clear and free from injurious amount of oil, acid, alkali, organic matters or other harmful substances in such amounts that may impair the strength or durability of the structure. Potable water shall generally be considered satisfactory for mixing and curing concrete.
It shall comply with the permissible limits of solids as mentioned in IS:456.
In case of doubt, the Engineer may require the Contractor to prove, at latter's expense, that the concrete mixed with water proposed to be used should have a compressive strength not lower that 90% of the total strength of concrete mixed with distilled water.

The Engineer may require the Contractor to get the water tested from an approved laboratory at his own expense and in case the water contains any sugar or an excess of acid, alkali, any injurious salts etc. the Engineer may refuse to permit its use.

Water shall be provided to the Contractor at one source of supply. The Contractor shall make his own arrangement for distribution, subject to prior approval of Engineer-in-Charge, to avoid interference with other facilities. He shall make his own arrangement of storing water by leakproof tanks sufficient for at least 24 hours.

6. WATER STOPS (WATER BARS)
The water stops shall be made of PVC Rubber or GI Sheets as called out in Drawings. Water stops wherever called for in the drawings shall be preformed trips of impermeable material. It shall provide a permanent watertight seal along the entire joint against a maximum pressure of five (5.0) M water column. It shall retain its stiffness, flexibility and tensile strength between wide limits of temperatures and pressure.

PVC Water Stops:
Material used for water stops shall be polyvinyl chloride. Water stops shall be ribbed, type 101 CALIPLAST or approved equivalent.

Rubber Water Stops:
They shall be of standard make such as AZP, Copper stop Past or approved equivalent and of type and width as described in bill of Quantities. The work shall be done as directed by the Engineer-in-Charge.

The jointing of two water stop lengths where necessary shall be one strictly by vulcanising as per manufacturer’s specifications.

GI Water Stops:
Where called out on the drawings, the water bars shall be “20” gauge G.I. sheets of required width and shall be bent, folded to shape, soldered and fixed as per the drawings and the directions of the Engineer-in-Charge. The galvanised sheets shall have medium coating of zinc as per IS:277.

7. REINFORCEMENT
All reinforcement shall be free from loose mill scales loose rust and coats of paints, oil, mud or other coatings.

Mild Steel Reinforcement:
Mild steel and medium tensile steel bars conforming to IS:432 Part-I.

Twisted Steel Bars:
Cold twisted steel bars, plain or deformed conforming to IS:1786. Hot rolled mild steel and medium tensile steel deformed bars conforming to IS:1139.

Hard Drawn Steel Wire Fabric:
Hard drawn steel wire fabric for concrete reinforcement shall conform to IS:1568.

Storage:
Reinforcing bars shall not be kept in direct contact with the ground but stacked on suitable platforms. Such stacking shall preferably be done diameter wise.

In case reinforcing bars have to be stored for longer duration, they shall be stored under covered shed. Fabricated reinforcement shall be carefully stored to prevent damages.
The mild steel binding wire shall be 16 gauge annealed conforming to IS:280.

8. BRICKS
Bricks shall be of first class quality conforming to IS:1077 and sound, hard, well burnt with uniform size, shape and colour, homogenous in texture and free from flaws and cracks. The standard size of the bricks shall be 9” x 4 1/2” x 2 1/2” and no dimension shall vary more that 3 mm from these standard dimensions. A brick shall give a metallic ring when struck with a light mallet or dropped flat from a height of 1.2m on the ground and shall have compressive strength of 50 kg/cm² minimum. No brick shall absorb more that 20% of its weight when dry after immersion and stacked directly from the vehicle. They shall be unloaded by tipping.

If locally available bricks do not meet the stipulated standards, Contractor may use locally available bricks subject to the necessary tests and approval of the Engineer-in-Charge.

9. STONE
Building stone shall conform to IS:1127. Stone shall be strong, dense, compact, close grained and uniform in texture and colour. The stone shall be properly dressed after quarrying before they are put to use. Stone newly quarried containing quarry sap shall be protected from frost until the quarry sap evaporates.

10. STRUCTURAL STEEL
Material for various purposes shall conform to the relevant Indian Standards, the important of them are as noted hereunder.
Structural Steel IS:226
Steel Tubes IS:1161
Bolts and Nuts IS:1367
Electrodes for welding IS:814 & 815

All materials shall be new and of unused stock. In case the steel supply is in Contractor’s scope, manufacturer’s test certificate shall be made available to the Engineer when asked for. Storage shall be similar to that for reinforcement.
• The steel work shall be erected unpainted, but all dirt, grease, rust and mill-scale shall be removed.
• All joints shall be fully welded with the electric arc process. All visible joints shall be planned with a grinder.
• The size and number of cleats, dowels, holdfasts, bolts, etc., shall be as per Architect / Consultants instructions.
• All exposed steel work shall be brushed finish unless otherwise specified.

1. Siporex Blocks: Siporex blocks to be used in masonry shall be “SIPOREX BLOCK” manufactured by Siporex (I) LTD., PUNE. The blocks shall be thoroughly soaked in water for eight hours before use. Joints in Siporex masonry work shall be raked 1/2” deep as the work proceeds and before the mortar sets. All the masonry work shall be thoroughly watered and wetted at least three times a day for 10 days. The joint in Siporex masonry shall not exceed 3/8” in thickness. Siporex block masonry in 4” or 8” thickness shall be done in cement mortar 1:4 proportion (1 cement: 4 sand).

2. Cement: The Cement used shall be ordinary Portland cement conforming to IS: 269. It shall be any one of the following makes i.e. L & T, Gujarat Ambuja, Rajashri & T, Narmada or ACC preferably supplied in paper bags. Cement shall be used in the order in which it is received (i.e. first lot received should be used first, second lot received should be used second etc.). Cement in bags in storage for more than 3 months shall be tested before use.

3. Cement Testing: A sample taken once for every 1000 bags shall be tested. Tests shall be carried out for fineness, initial and final setting time and compressive strength (IS: 4031) and the results approved by the Engineer before use of the cement in permanent works. Samples shall be taken immediately on receipt of cement at site. The methods and procedure of sampling shall be in accordance with IS: 3535. The Engineer
may specify other forms of sampling and tests including chemical analysis, (IS: 4032) if in his opinion the cement is of doubtful quality, the cost of such additional tests shall be borne by the Contractor, otherwise the cost of testing will be borne by the Owner.

4. **Sand:** It shall be river or pit sand conforming to IS: 383, obtained from sources approved by the Engineer. If considered by the Engineer as necessary, the sand shall be washed. This shall be done at least one day before using it in concrete and/or in plaster. Sand shall be clean sand of approved quality free from salt, earth, dust or other impurities. The sand should be stored in such a manner as to avoid contamination. If grading of sand can be improved by mixing two sands, the Engineer may at his discretion specify such mixing, and may permit the use of crushed sand as one of the two sands forming the mixture. The provision of two types of sand and their mixing in the specified proportions shall be at the Contractor’s cost.

5. **Sand Testing:** The sand shall be subjected to tests in accordance with IS: 2386 as may be ordered by the Engineer.

6. At every 1200mm height, all Masonry shall have a 100mm thk cast in situ R.C.C band laid in a 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate, 12.5mm nominal size down-graded), in partition walls including providing, laying and fixing tested quality, mild steel reinforcement 2 Nos. 8mm dia. bars at bottom and 2 Nos. 8 mm dia. at top with 6mm dia, stirrups spaced at 300mm centers.

7. **Brick work:**
   - All brickwork shall be carried out as per IS 2212: 1991.
   - The building bricks are to be the best quality table moulded kiln burnt, patent bricks, hard sound, square with sharp arises, even and uniform in shape and colour, free from cracks, stones, flaws and other defects.
   - Samples of bricks are to be submitted to the Architect for approval before full quantity is ordered. All supply of brick shall conform to the sample approved.
   - No brick after 24 hours immersion in water shall absorb water more than 15% of its own weight.
   - All bricks to be plastered are to afford a good key.
   - The cement and sand mortar is to be composed of one part cement to four parts of sand by volume, thoroughly mixed by machine. If mixed by hand 10% extra cement shall be added to mortar.
   - No mortar that has commenced to set shall be used in the work.
   - Every brick shall be thoroughly soaked in water before use. Broken bricks shall not be used except as closures. The courses shall be truly horizontal and the work strictly plumb, joint shall be broken vertically and they shall not exceed 1/2” in thickness. All joints in brickwork are to be well filled with mortar.
   - The brickwork shall not be raised more than 12 single courses per day and shall be built in English Bond, except brick on edge (brick cladding) and half brick thick walls shall be built in structure Bond. Except for brick on edge work (Brick Cladding), the bricks shall be placed with “frog” facing upwards.
   - All joints in brickwork shall be raked out 1/2” deep as the work proceeds, and before the mortar sets.
   - At every 1200mm height, all Masonry shall have a 100mm thk cast in situ R.C.C band laid in a 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate, 12.5mm nominal size down-graded), in partition walls including providing, laying and fixing tested quality, mild steel reinforcement 2 Nos. 8mm dia. bars at bottom and 2 Nos. 8 mm dia. at top with 6mm dia, stirrups spaced at 300mm centers.
including lappings. • The brickwork is to be carried out with all necessary set backs, projections, cuttings and toothings in conformity with the drawings.

- The brickwork shall be cured by watering at least three times a day for 10 days, and the work shall be well protected during the rainy season.
- All uneven, irregular and bad brick work poor in workmanship shall be demolished if deemed necessary by the Architect and rebuilt by the Contractor at the contractor’s expenses.
- If necessary the contractor will have to provide wooden plug, etc., for his own work and for which there will be no special payment on that account.
- The work will have to be executed at any height and lift will not form the criterion for any extra amount.
- The rates for brickwork should include cost of all materials and labour, the cost of providing and fixing necessary single or double scaffolding and removing the same after the work is completed, watering, curing, lifting of materials to any height, raking of points to receive plaster, forming cavities for expansion joints, cutting or leaving holes for legs of windows, doors etc., conduits, pipes, bolts or other articles passing through wall etc., complete.

- Should any efflorescence be observed in brick work, it should be washed down by clean water and brick surface treated with such chemicals as are deemed necessary by the Architect without any extra charge and at the Contractor’s own expense, till efflorescence subsides. Should the efflorescence persist, the brickwork shall be demolished if deemed necessary by the Architect and the work rebuilt with new bricks including making good all the work disturbed without any extra charge.
- Finishes to the brickwork such as plaster and cement pointing will be paid for separately under “PLASTERER”.
- 115 mm thk brickwork shall be called as half brickwork. Laying bricks in stretcher bond shall build it. Mortar shall be as specified in the BOQ. These walls may be used for forming cavities or partition walls inside buildings.
- One brick or more thick walls shall be measured in cubic meter that is length multiplied by the thickness. Thickness shall be measured in multiplies of half brick which be deemed to be inclusive of the mortar joints. Half brick thick or brick-on-edge walls shall be measured in square feet.
- Deductions shall be measured the net sizes of the openings and recesses. No deductions shall be made for the openings 0.1 Sq.m and under.
- Lintels will not be deducted from the volume and/or area of brickwork and cost for the same will be included in the cost for brickwork.
- Anchoring, horns of teakwood frames fastened into the masonry will not be deducted.
- Mortar and plaster shall be mixed in G.I. trays or in similar arrangement and not on the existing floor.
- Mortar for block work and brick masonry shall be 1 part of cement to 4 parts of sand by volume, unless otherwise specified. Joints shall be raked out to a depth of 1/2 inch.

8. Plaster

- The Portland cement used for plastering shall be Grade 43.
- The sand to be used shall conform to IS 1542: 1992.
- The sand to be sieved so that it shall not contain particles greater than one eighth of an inch and shall be most carefully washed.
- The sand for external plastering is to be clean and the whitest available. Sand from beds of rivers carrying saline water is not to be used.
• The surface to receive plaster shall be cleaned of all dust, dirt, and mortar sticking on surfaces etc., and the masonry (concrete, brick or stone) shall be thoroughly watered, for 10 hours immediately prior to applying backing coat.

• The external plaster shall be of two coats of an overall thickness of 20mm, backing coat to be one part cement and six parts of sand by volume and finished fair and even applied after adequate interval and finished as specified in the Schedule of Quantities. Backing coat shall be combed on wet surface to form keys for finishing coat. External plaster shall be waterproofed with approved waterproofing powder added to cement in proportion of 1.5 kg, to 50 kg of cement as per the manufacturers' specification for both the coats.

• The internal plaster shall be of one coat of an over all thickness of 3/4" of one part cement and four parts of sand by volume, finished smooth without neeroo finish to receive coat of P.O.P. To form a base or key for P.O.P., the plastered surface shall be finished even.

• For rough cast plaster, the backing coat when hard but still wet, shall be floated 3mm thick with cement mortar (1:4) proportion with fine sand, spread in small areas at a time not exceeding 25sqm and whilst it is still wet, the rough cast containing a mixture of 1 part of cement, 2 parts of fine sand and 1 part of pea-gravel 3mm to 6mm size shall be dashed on the floated coat to a uniform thickness of 18mm and finished in level, and even surface.

• The internal plaster for ceilings shall be of one coat of an over all thickness of 12mm of one part cement and four parts of sand by volume, finished smooth with thin layer of neeroo finish. To form a base or key for neeroo, the plastered surface shall be combed with wire brushes.

• Neeroo Layer to be applied will be prepared as detailed below:

The lime for preparing neeroo shall be from approved sources and shall be slaked lime power.

i) Slaked lime powder shall be added to water in preparation tanks to form thick slurry. The slurry shall be sieved through a fine mesh sieve (12 meshes per lineal inch) and allowed to settle in the tank for thorough slaking for a period of not less than twenty days. The surplus water in the slurry shall be drawn off or allowed to evaporate before use.

ii) The slaked lime paste thus formed shall be used for preparing neeroo.

iii) Neeroo shall be prepared by mixing together 4 Cft. of the slaked lime paste, 1/3 Cft. of Portland cement, 1 Cft. of fine sieved sand and 9 pounds of finely chopped jute fiber, thoroughly mixed with sufficient water to form a paste of the desired consistency.

iv) The finishing coat of neeroo prepared as above shall be applied with steel trowels to a uniform thickness in a thin layer and finished smooth by steel toweling.

• Where smooth finished internal cement plaster is specified in schedule of quantities to receive wall paper decoration, layer of neeroo finish will not be applied, but the plaster surface will be finished smooth with floating coat of neat cement and even by wooden floats and steel toweling.

• Where rendering is specified in internal plaster in “Schedule of Quantities”, it will consist of only a backing coat 3/4" thick in (1:4) cement mortar applied uniformly and evenly by wooden floats but not finished smooth.

• All angles, arises in external and internal plaster must be finished straight, true and sharp.

• Plastering of entire or unobstructed area shall be done at one stretch and on occasion when arising due to the extent of the area being too large or for some other reason, the work is to be left
over for completion on the next working, down with carborandum stone or the work carried out in such a manner as to have no marks left in the finished work.

- All plaster shall be kept wet for seven days after being applied.

- No paint, distemper, colour wash or white wash shall be applied to plastered surfaces for at least two months or until the contractor has satisfied the Architect that the walls and plaster are thoroughly dry. Brickwork above false ceiling heights will be flush pointed in cement mortar (1:4) and will be plastered. The soffits of slabs, beams above false ceilings will be plastered.

- The rates quoted should include for all materials and labour and for execution of work at any level. Lift of materials will not form a criterion for any extra amount. It also includes providing and fixing scaffolding and removing the same after completion of work, raking out joints, hacking and hatching the concrete surface and providing the key for holding down the plaster, watering, curing etc., complete. Nothing extra will be paid for work in arises, rounded angles, fair edges, narrow returns, quirks, V-joints, splays, drip mouldings, making good around pies, conduits, timbers, cills, brackets, railings etc., and making good after all the specialists have done their work. Measurement will be of the actual area of work done. No deduction in quantity will be made if the superficial area of any individual opening is less than 2.0 square feet.

- Plaster and pointing will be measured in Square meter of actual work done.

- Plaster samples approx. 3' x 3' in size be prepared prior to execution of work for the Architects approval. Nothing extra shall be paid for the same.

9. Waterproofing for Toilets

- **Floor**
  
i) Chasing, grooving and grouting the junction of floor with the drop wall in polymer cement grout.
  
ii) Giving polymer cement slurry injections by gravitation method until full saturation as required.
  
iii) Laying total 50 mm thick waterproof screed in cement concrete (1:2:4) with 2% Proofsol in two layers of 25 mm thickness of each smooth finished including coving at the junction.

- **Walls**
  
i) Racking out the joints of masonry and grouting the same.
  
ii) Applying chemical wash mixed with cement
  
iii) Providing 10 mm thick cement mortar (1:4) waterproof rendering with 2% Proofsol for the full height of bath walls in toilet block and 1200 mm height for rest of the walls.

- **Brickbat coba filling in sunk portion**
  
i) Laying 10 mm thick cement mortar (1:4) with 2% Proofsol as padding coat.

- The work will have to be executed at any height and lift will not form the criterion for any extra amount.
  
ii) Providing half cut bricks and brick bats of required size over the green mortar pad and grouting the joints in cement mortar (1:4) with 2% Proofsol.
  
iii) Providing 6 mm thick cement mortar (1:4) with 2% Proofsol screed topping, rough finished to receive flooring.
10. **Flooring/ Dado**

- Hydrophobic cement as per IS 8043 used in mortar shall be thoroughly machine mixed.

- Contractor shall submit samples of all kinds of tiles, stones marble etc., for approval before ordering the same.

- Where required the flooring shall be machine polished.

- Surface to receive flooring tiles etc., shall be cleaned thoroughly from all dust, dirt, mortar deposits, laitance, water etc., and washed clean with water.

- Cement mortar bedding in proportions specified in the Schedule of Quantities shall be laid in such levels and thickness as required in the area of work. The thickness mentioned in the schedule of quantities is only indicative and may vary in some particular areas. No extra will be paid on account of any variations in thickness of the bedding mortar. The bedding mortar shall be compacted with wooden floats and floated with neat cement slurry for fixing the tiles.

- The joints in tiles shall be neatly pointed with coloured cement to match with the tile.

- Marbles / Stone shall adhere to IS 1130: 1969 code and shall be the best Indian/ Italian Marble or stone as approved by the Architect. The quality shall be uniform and it shall be hard and free from any discolourations, cracks, flaws, veins of foreign materials or any other defects. When marble/stone of different colour and kinds associated care shall be taken to see that they are of equal hardens so as to wear evenly. The marble/stone slabs shall be machine cut true to the shape and size and machine polished. Care shall be taken to cut the slabs so as to provide a pattern as indicated. Marble/ stone slabs for wall lining and dadoes shall be machine polished before they are fixed in position and shall have machine cut and polished edges. The wall shall be lined with the marble/stone in courses as indicated and grain of the marble/stone shall be arranged in pattern as per detailed drawings. The marble /stone shall be bedded in cement mortar backing covering the full area of the marble/stone. The wall surface shall be cleaned from all dirt, mortar droppings etc., before applying the base plaster. The marble /stone shall be fixed to the walls by Bronze cramps 5" X 1-1/2" X 1/4" and bronze pins 1/4" diameter X 2: embedded firmly into wall by cutting hole and grouting. The load of one marble /stone slab shall not be borne by the slab below. Joints between slabs shall be hair fine and filled with coloured cement to match the marble/stone. The marble /stone lining and dadoes shall be finally hand polished by carborandum stone, buffing with polishing felt and cleaned with diluted oxalic acid wash. Slurry arising out of polishing shall be removed out of building by buckets. Contractor shall not dispose the slurry into the drain, pipes or other fittings.
- The marble/stone shall be sealed if specified in the schedule of quantities. The sealant shall be of aquamix or equivalent make (approved by the Architect) and shall be applied as per Manufacturer’s instruction and specifications.
- Kotah stone slabs and tandoor stone slabs to be obtained from approved quarries and to be free from all defects, variations, grains or patterns and shall be hard and uniform. Quality checks, polishing, fixing, cleaning specifications etc. will be the same as for marble as described in points above.
- Coloured ceramic pattern glazed tiles, white glazed tiles shall be ‘Kajaria’ make (or any other equivalent make approved by the Architect) in sizes and specified in the schedule of quantities. The Architect will select the pattern and colour before ordering these items. Chipped, cracked or worn out tiles shall not be used in the work. The tiles shall be minimum 1/4” thick and the best quality.
- Marble Mosaic tiles and specials (half tile skirting) shall be of the best quality and of approved make. Tiles shall be minimum 3/4” thick having a base 1/2” thick in cement and sand mortar in proportion (1:3) with top layer of 1/4” thick in neat coloured cement and marble chips facing. They will be compacted under minimum pressure of 300 lbs. per sq.ft. All the edges shall be exactly to size free from chipping and the top surface and edges shall be smooth, but the base shall be rough. The marble chips shall be in selected sizes in 75% proportion and other chips shall be smaller and of approved colour in neutral shade. The tiles and specials shall be cured in water for at least one month before delivery. Bedding mortar shall be as described in “Schedule of Quantities” and joints shall be pointed in coloured cement to match. Tiles fixed in position shall be cured for 15 days by constant watering and then polished with machine to obtain a smooth polished surface, and washed clean. Slurry arising out of polishing shall be removed out of building by buckets. Contractor shall not dispose the slurry into the drainpipes or other fittings. Skirting tiles shall be hand polished with carborandum stone.
- Indian patent stone flooring shall be 1 - 1/2” or of thickness specified and laid in two layers, bottom layer 1 - 1/4” thick or as specified in 1 part of Portland cement, 2 parts of sand and 4 parts of crushed stone aggregate 1/2” down well graded machine mixed with not more than 5 - 1/2 gallons of water for each bag of cement and top layer 1/4” thick in 1 part of Portland cement, 2 - 1/2 parts of selected crushed stone chips 1/8” down with just enough sand maximum 1 part to make workable mix, machine mixed with not more than 5 gallons of water. Top layer to be laid before the bottom layer has hardened. Flooring shall be laid in squares or bays as directed and each layers shall be well compacted by ramming with heavy teakwood floats. The top shall be brought to a smooth and even surface free from blemishes and finished smooth by steel toweling. After the concrete surface has hardened sufficiently to prevent dislodgement of aggregates, the patent stone shall be polished with No. 1, 2 & 3 polishing stones. The flooring shall be kept wet for 7 days for curing. Where Ironite topping is specified in the “Schedule of Quantities” the bottom layer shall be 1” thick (instead of 11/4”) as described above and the top layer shall be mixed with "ironite" as per manufacturers specification and finished fair.
- The rate quoted should include for all materials and labour and for execution of work at any level. Lift of materials will not form a criterion for any extra amount. It also includes providing and fixing scaffolding and removing the same after the completion of work, machine polishing, double polishing and hand polishing, curing and cleaning the entire work on completion.
- Flooring paving and wall tiling will be measured in square meter of actual work done.
- Flooring Joints: Floor tiles/stone slabs in flooring shall be close jointed to obtain fine line. All joints shall be true to straight lines and unbroken. All cross-joints to be line right angles. The joints are filled by rubbing over the floor with a brush, a slurry of neat Portland gray/white cement with pigment to match
the stone/tiles/marble/granite, and polymer binding as required before the cement has set the surplus cement/pigment is cleaned off the face of tiles with dry deal sawdust. All joint lines shall be of regular straight pattern with joints crossing each other at true right angles. The tiles/stone shall be generally leveled with a wooden staff and the joint lines regulated and straightened before the bedding cement begins to set.

- Precaution: Flooring in lavatories and bathrooms shall be laid after fixing of water closet and squatting pans and floor traps. Traps shall be plugged, while laying the floors and opened after the floors are cured and cleaned. Any damage done to W.C’s squatting pans and floor traps during the execution of work shall be made good.

SPECIFICATIONS FOR TIMBER

1. TIMBER
Timber shall be fully matured, well seasoned 1st quality CP Teak for structural items and either 1st quality CP Teak or well seasoned Burma Teak for non structural woodwork such as doors and windows etc unless otherwise specified for the particular job (the Contractor shall furnish from a recognised timber merchant a certificate as to its seasoned condition and the date of its cutting into scantlings) free from all knots, shakes, cracks, dry and wet rots or defects of any other kind. Only the heart wood of a sound tree, from which the sap has been entirely removed; sap wood or the wood that is found to be soft or of a spongy nature at any portion of the scantling under consideration will be rejected and only which is uniform in substance, straight in fibre and of uniform hardness shall be used on the works. The colour should be uniform throughout.

The Consultant or his representative may inspect all logs and scantlings previous to use and reject any which he considers defective in the requirements of the specification. The Consultant shall have the power to reject at any stage any work which may be found defective in quality or workmanship and he shall not be debarred from rejecting wrought timber by reason of his having previously passed the same in the log or other un-worked state. Rejected timber and woodwork shall be removed from the site of the work within 24 hours of rejection at the Contractor's expense.

No wood work shall be placed in position, covered in the ground or walls, unless and until it has been approved by the Consultant his representative; otherwise, it is to be removed or payment proportionately deducted, at the discretion of the Consultant. The Contractor shall, therefore, give due notice to Consultant or his representative for inspection. The preliminary passing by the Consultants\Clients representative will be done in systematic manner with the blue chalk or light stamp supplied by the Contractor.

2. WOOD WORK, CARPENTRY AND JOINERY
The whole of the timber used to be of best 1st quality CP Teak or Burma Teak first quality or second hand Burma Teak (for non structural members) of the dimensions and forms shown in the drawing or as described by the Consultants. The wood to be in every case, of the best description, full grown, sound, free from large and loose or dead knots twists, shakers, sun cracks, flaws or other defects and to be of hard wood and well seasoned.

The tolerance permissible in teak wood shall be as follows:
   i) Sap wood to the extent of 20%
   ii) Warp to the extent of 10mm in 3 metre length.
   iii) Live knots of 2 knots per metre the diameter of each knot not exceeding 20mm.

Any wood found to be not up to the above standards is liable to be rejected by the Consultants/Engineer-in-charge. The Consultants decision in this regard will be final and binding.
All mortise and mitre joints tenons, scarf’s etc. to be made and fitted accurately in a workman like manner in accordance with working Drawings or directions and to the satisfaction of the Consultants. All joints shall be properly glued with an approved first quality glue. If, after the wood work shall have been erected any undue shrinkage or bad workmanship show themselves, the Contractor shall forthwith amend the same without any extra change.

The rate of wood work to include all sawing, planning, joining, framing labour and material for raising and fixing and all workmanship also the fitting, fixing and supply of all straps, bolts, nuts, nails, spikes, screws etc. necessary for the framing and fixing. All holes for fixing bolts shall be accurately centered and drilled to the exact size of the shank diameter and countersunk when required.

All timber resting on or embedded in masonry to be well tarred with boiling coal tar.

The measurement of all wood work to be for actual visible portion and no allowance will be made for tenons overlaps etc.

All exposed faces of wood work shall be sand papered once before erection for approval of the Consultant. No colour or other preservatives shall be applied without prior approval of the Consultants.

The whole of the wood work shall be first treated with two coats of anti-termite wood Preservative chemicals of an approved make and the contractor shall strictly observe the manufacturer’s instructions for using the material. All the wood shall thereafter be applied with a primary of approved first quality wood primer paint. The application of primary shall not be done within 24 hours of the application of the second cost of anti-termite treatment. The wood work shall be made perfectly clean and smooth before painting. Framed joints must be coated with the wood preservative and the primer before being put together.

The Contractor shall provide to store the timber during construction. Timber that has deteriorated on account of exposure to damp is liable to be rejected.

The rates entered in the Bill of Quantities must be held to include the cost of haulage to the work site, housing and protecting from weather, risks of every kind and all expenses connected with the preparation and use in the work. The cost of primer an wood preservative as specified is to be included in the cost of wood work to which it is applied.

3. TIMBER TREATMENT

All structural timber members, should be treated with anti-termite coat and one coat of solignum.

**For old BTC structural members (apply by brush)**
- Apply 1 layer of turpentine oil – let the sample dry
- Apply 2nd layer: 1/3 linseed oil and 2/3 turpentine oil mixed and let sample dry
- Apply 3rd layer: 2/3 linseed oil and 1/3 turpentine oil and let sample dry
- Apply 4th layer: full linseed oil and let sample dry.
INDIAN STANDARD CODE FOR USE OF TIMBER

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4. PAINTING & POLISHING OF DOOR AND WINDOW FRAMES

External doors and windows on all floors, in the corridors and lobby need to be consolidated, using teak wood infills where necessary and to the specified designs of brass hardware. The application of a clear propriety preservative is recommended, such as clarified beeswax dissolved in pure turpentine oil, finally rubbed down by a soft cloth. Microcrystalline waxes may be used, at a suggested loading of 25 cc of wax per litre of preservative.

External doors and windows should also be consolidated using teak wood inserts where necessary, with a view to using second hand teak that has been properly seasoned. Exterior timber members exposed would be either French polished and coated with 3 coats of clear PU coating or with primer and 3 coats of specified specified enamel paint of brand approved by Architect.

5. HARDWARE

The hardware used shall be consistent for the entire work and from the approved manufacturer. The Contractor may have to provided a range of samples from different sources before the decision for the exact material make is arrived at and no extra shall be claimed or delay for work in this regard.

1. Brass hardware of heavy duty guage of approved grade shall be used

2. Stainless steel to be of grade S.S 304 with gauge not thinner than 16 SWG or as specified in the details.

3. All brazing and welds to be executed in the best possible finish of workmanship, rubbed down and completed in the flattest and tidiest manner, especially where exposed.

4. Chromium plating shall be in accordance with IS Standard for general outdoor conditions and shall be on a parent material of copper or brass.

5. Unless otherwise specified, fittings shall be brass oxidised and approval would have to be obtained from the Architects before being used for the project work.

6. The Contractor should adequately protect the brass and bronze surfaces by application of a thick grease or other suitable protection layer, reapply as required from time to time and clean away completely on completion.

7. Screws are to perfectly match the finish of the article to be fixed and are to be round or flat headed or counter sunk as per details and in non corrosive brass or SS 304 grade.
6. GLAZIER

1. All glass should comply with IS 3548 – 1966 or as directed by Architect as per the approved sample and free from bubbles, smoke, wanes, air holes and any other defects.

2. ‘Glazing Glass’ (G.G) quality polished plate glass shall be used and mirrors shall be ‘Silvering Quality’ (S.Q) conforming to IS 3438 - 1965, as per approved sample and quality.

3. The compound for glazing to metal is to be a special non-hardening compound manufactured for the purpose and of the brand and quality as approved by the Architects.

4. Proper allowance to made for expansion while cutting glass. Each square glazier to be on whole sheet. Glass surfaces should be cleaned on completion and all chipped broken panes should be removed immediately from site.

5. The quoted rates for glass work to include cutting, handling, breakage, transport etc., and any claim for extra shall not be entertained.

HARDWARE

The hardware used shall be consistent for the entire work and from the approved manufacturer. The Contractor may have to provided a range of samples from different sources before the decision for the exact material make is arrived at and no extra shall be claimed or delay for work in this regard.

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14. Screws are to perfectly match the finish of the article to be fixed and are to be round or flat headed or counter sunk as per details.
FINISHING WORKS – PAINTING/PolISHING WORKS

1. **Internal Walls (POP finish)---if to be lustre painted:** All the internal walls surfaces shall be scrapped down thoroughly with Emery paper (180) and wiped clean followed by a coat of Asian paints wall Primer (E1) and then a coat of Asian paints Acrylic Wall Putty (E0). The surface shall be again scrapped down thoroughly with Emery paper (180) and wiped clean followed by a coat of Asian paints wall Primer (E1) followed by another round of scraping down of surface with Emery paper (320) and wiped clean followed by 2 coats of Asian paints Interior wall finish lustre (LF) of approved colour shade.

2. **Steel Work:** Shall be rubbed down thoroughly and coated with one coat of approved zinc-chromate, anti-rust metal primer, and if exposed followed by 1 coat of ready-mix enamel putty followed by 1 undercoat and second coat of putty rubbed down with emery paper and water and 2 finishing coats of specified coats of enamel paint using thinner as required, hand brushed or sprayed.

3. **Internal Walls (POP finish)---surface preparation if to be texture painted:** All the internal walls surfaces shall be scrapped down thoroughly with Emery paper (180) and wiped clean followed by a coat of Asian paints wall Primer (E1) and then a coat of Asian paints Acrylic Wall Putty (E0). The surface shall be again scrapped down thoroughly with Emery paper (180) and wiped clean followed by a coat of Asian paints wall Primer (E1) followed by another round of scraping down of surface with Emery paper (320) and thus preparing the surface for receiving the texture paint.

4. **General procedure for Lustre Finish, Acrylic Emulsion and Enamel Painting:**
   - Sand papering and cleaning the surface properly.
   - Filling the minor cracks/holes with plaster of Paris.
   - Applying one coat of cement primer mixed with 15% of doubled boiled linseed oil.
   - Sand papering and applying lambi/putty twice.
   - Applying second time cement primer to the full surface.
   - Sand papering and applying third time touch-up lambi/putty.
   - Sand papering the putty works and painting with three coats of required paint after providing touch-up with lambi/putty in every coat.

5. **General procedure for Water Cut Enamel Paint** (4 coats – if required)
   - Sand papering the surface and applying one coat of wood pink primer or flat oil plant.
   - Applying lambi/putty to the full surface twice.
   - Water cutting the surface by waterproof paper and applying a coat of enamel paint to the full surface.
   - Water cutting the surface by waterproof paper and applying a coat of enamel paint to the full surface.
   - Sand papering the putty works and applying second coat of enamel paint.
   - Water cutting by waterproof paper and applying third coat of enamel paint.
   - Final water papering, minor touch-up and applying fourth ad final coat enamel paint using good quality thinner in place of turpentine.

6. **General procedure for Texture Finish or Stucco Paint**
   - Sand papering, cleaning the surface properly.
   - Filling the cracks/holes with plaster of Paris.
   - Applying one coat of double boiled linseed oil with mixed cement primer.
   - Providing a coat of lambi/putty to the full surface.
• Sand papering the putty works and applying second coat of cement primer
• Sand papering the surface and making 'texture finish' using roller or by hand as required. (Using Zinc moist + enamel paint + whiting)
• Then painting with two coats of luster paint

7. General procedure for Duco Paint
• Sand papering filling cracks/holes with M/Seal crack filler
• Applying a coat of 'Duco' oil primer
• Leveling with one coat of lambi/putty to the full surface
• Water cutting the putty works and spray one coat of N.C. gray surface
• Providing two times N.C. putty to the full surface
• Water cutting the surface, applying second time surface or white N.C. paint
• Water cutting the surface applying touch-up lambi/putty wherever required and then painting with three coats of Duco paint.

8. General procedure for Design Type Painting
• Shading/Stippling/Marbling by either brush, sea sponge, rag rolling or artists brush as required.
• Applying minimum two coats of lacquer (sprayed) at 'Duco' I.C.A. make or 'Krillo' - Asian Paints make.
• Rubbing/Buffing with Rubbing Compound of 'Waxpol' or 'I.C.A.' make.
• Final cleaning with 'Liquid Polish' of I.C.A. make.

9. Mode of Measurement
• Painting works of plain surfaces measured as usual i.e. Length x Width = Area
• If any delicate or intricate areas with designs, grooves, curves, moulding etc., are involved, the mode of measurements for such works shall be indicated by the 'Contractor' on the basis of the actual conditions obtaining at site and approval by the Architects, prior to taking up such works in hand.
• Glass doors/windows with mouldings and sash bars to be painted both sides in single shade will be measured on one side only and multiplied by 2.25 times i.e. length x breadth x 2.5 times. No extra measurements for moulding, window jamb thickness etc. Also no deductions for glass openings etc.
• Ordinary windows painted on both sides shall be measured on one side only (wall to wall including jambs) and multiplied by 1.5 times i.e. length x breadth x 1.5 times no deduction for glass panes.
• M.S. grills shall be measured on one side and multiplied by 2 times i.e. length x breadth x 2 times.
• All non painted or polished surfaces shall be thoroughly cleaned without scratches or any kind of damage before handing over and nothing extra shall be payable for cleaning of these items like, windowpanes, flooring, partitions etc.
• All junctions between polished surfaces and paint surfaces shall be neatly line cut in a very crisp and perfect manner such that no junctions look smudged or crooked.

10. Materials manufactured by the following manufacturers shall be used:

a) Cement Primer : Asian Paints, Duco or equivalent.
b) Enamel Paint for lambi/putty : Asian Paints, Duco or equivalent.
c) Enamel paint for finishing : Asian Paints, Duco or equivalent.
d) Flat Oil Paint : Asian Paints, Duco or equivalent.
e) Luster Paint : Asian Paints, Duco or equivalent.
f) Linseed Oil : 1st Quality Man of War brand of M/s. A.N. Irani & Co.,
g) Duco Paint : I.C.A, Asian or equivalent.
h) Oil Primer or Surfacer : I.C.A, Asian or equivalent.
i) N.C. Putty : N.C. Putty of Esdee make, Oil Putty of Addison Paint.
POLISHING WORKS

1. All exposed t.w. and veneer and all internally visible t.w. and plywood shall be through thoroughly sand-papered and cleaned, and melamine polished.

2. Staining, preparation, filing and finishing coats shall be done strictly as per manufacturers recommendation (example Asian Paints I. Ltd.) Sample of stain and finish shall be submitted to the Architect/Consultant for prior approval.

3. Linseed Oil

Procedure
a) Scrapping all the surfaces filling all the cracks / holes.
b) Applying 5-6 coats of linseed oil along with turpentine using a muslin cloth with slight pressure, so that the oil gets filled into the grains.
c) The proportion of linseed oil to turpentine varies from 80:20 to 60:40, 40:60, 20:80 and so on with every next coat of oil.
d) The final finish on top shall be of matt applied by brush

4. French Polish

For French Polish the base material shall be shellac dissolved in methylated spirit. The timber shall be well sanded and prepared and the grains to be filled with a grain filler. Staining if prescribed must be done before application of the polish. The equipment consists of the polishing rubber which is to be a wad of cotton wool and a cover of a soft linen or cotton fabric. This rubber must never be soaked into the polish with the cover removed. Polish is to be applied uniformly over the surface with a slow figure-of-eight motion until the timber is coated with a thin layer of polish. A series of thin even coats to be applied allowing only for a few minutes for drying in between application. This layer on achievement of an even surface is then spirted off with methylated spirit to remove the rubber marks and to achieve a smooth finish.

Procedure
a) Sanding of the raw surface of wood/ply/Veneer: Sand the wood/ply/Veneer surface with 80 number sandpaper (of roughest grit). In case of veneered surface, use 120 or 150 no sand paper). Wipe clean the sanded surface with a clean cloth.
b) Do note that:
   - More finished the raw veneer/wood, higher the sandpaper number chosen.
   - Sanding to be done in the direction of the grains.
   - The sanding shall be done till a smooth and even finish surface for polish is ready.
c) Colouring of the surface: Prepare a dry mixture of colored powders to achieve the desired coloured finish. The dry mixture consist of:
   - A whiting powder (microphile or chalk powder as it is known in Karnataka.)
   - One or more relevant colour powders (mahogany, black, raw sienna, burnt sienna etc) as per Architect’s approval.
   - All the powders shall be hand mixed.
   - Apply the mixture evenly onto the desired surface using a damp cloth and get the colour of the polish approved by the Architect at this stage.
   - In case if natural colour of the wood is to be retained, then the 1st coat of polish should be directly applied over the sanded wooden surface as specified by the Architect.
• Rub the surface gently with a clean cloth to remove excess colour. Care is to be taken that the powder is applied uniformly over the surface. This surface is left to be dried for some time before the polish is applied.

d) 1st coat of polish:
• Sand the surface with 220 grit sandpaper; this is to remove excess coloured powder so that the grains are distinctly seen. The powder shall adhere to the grains only. Wipe the surface with a dry cloth.
• Dip a cloth in the polish and apply the polish over the wooden surface evenly along the direction of the grains.
• Let the polish dry.

Composition of French polish:
1. Spirit.
2. Lac
3. Chandrush
4. Rumi mastagi

e) Test for authenticity of spirit: Dip a finger into the spirit solution and blow air over the finger; the solution should evaporate leaving no white coloured residue behind.

f) 2nd coat polish:
• Sand the surface with 220 grit sandpaper and clean the surface using a neat cloth
• Filling of the dents, cracks fissures in the wooden surface can be done at this stage.

Do note that:
• For the interiors, the dents etc should be filled with a mixture of wax and coloured powder, (’Kaccha’ wax is to be used to fill ply and ‘pucca’ wax is to be used to fill veneer and wood).
• For the exteriors, pucca lambi (a mixture of whiting, coloured powder and French polish) is used to fill the dents etc.
• Joints between plys and veneer can also be filled in using pucca lambi.

g) Repeatedly apply the 2nd coat of the French polish until all the polish ingredients are properly impregnated into the wood surface.

h) Colour rendering changes is if required by the Architect shall be made at this stage only.

i) 3rd and final coat:
• Sand the surface using 220 grit paper and again wipe it with clean cloth.
• Apply the final coat of French polish repeatedly until the surface gets an even sheen and all the grains are filled with polish ingredients.

j) Wax buffing:
For Wax Polish the base material contains silicon and dryers. A good silicon wax is used and not a cream or spray. Before the wax is applied, the timber is sealed first with another finish Ronseal. A light coat of sealer is applied by brush or cloth directly to the unfilled timber surface, working it in well and finishing evenly in the direction of the grains. It should be allowed to dry completely and then sanded lightly with fine abrasive paper. A heavy coat of wax is applied next, working in well and it is finished by stroking in the grains before leaving for hardening. This surface is then rubbed up with a soft brush but only after it is left to harden for several hours. The grain is then buffed with a soft cloth.
• Apply wax (shin-o-shine-white polish) with the help of a cloth and then rub the surface evenly with steel wool.
• Rub the surface again with steel wool for buffing to ensure that the surface is not left sticky or greasy.
• If the surface has to be PU finished, PU can be applied instead of the wax at this stage. This shall be done as per ICA or equivalent make company specifications only. However if the wood colour desired is ‘natural’ and PU is required, then the French polish is avoided, instead a sealer is applied (preferably using a machine) over which PU is applied.

k) Melamine Polish:
For Melamine Polish the base material consists of Polyurethene. Polyurethene gives touch surface that resists chipping, scratching and boiling water. Clean off all grease and dirt with an abrasive and white spirit. It is advised that it is not done in humid conditions. Apply the same coat, of preferably a clear hard glaze with a cloth pad. It should be allowed to dry for a minimum of 6 hours and then again coated. Subsequent coats should be rubbed down with fine glass paper or medium grade steel wool. A matt finish is then achieved, if specified, by giving a final coat of clear Ronseal Matt coat.

DOORS & PARTITIONS

• All floor springs shall be heavy duty two way of ‘Everite’, ozone or equivalent make (unless Dorma make specified) with brass plate covers, which shall be approved by the Architect.
• All patch fittings; floor spring, locks etc to be used in the glass partitions and glass doors shall be Dorma make and shall be matt brass finish.
• All dorma make specified patches, floor springs, door closers shall be as per the weight and other specification of the item as required, by the manufacturer to recommend the correct fitting for the said item.
• Items like spider glazing for the CFC, Sliding folding partitions (on the 2nd floor between the 2 big conference rooms shall be totally as per Dorma make specification as per suggestive dwgs attached in the document.
• All mortise locks & handles shall be of "Golden " make or equivalent.
• Concealed Door Closers shall be 'Everite make or 'Equivalent' to be approved by the Architect.
• All hinges used for the old doors shall be of parliamentary type and heavy duty with brass finish of flora, magnum or equivalent make.
• All hinges used for the new doors shall be heavy duty with brass finish of flora, magnum or equivalent make.
• All handles for the old doors shall be about 150mm tall, heavy duty, brass finish and decorative type as per Architect’s approval.
• All handles for new doors with frames shall have heavy-duty brass finish mortice handle with a keyhole at the bottom. The Tubular locks shall be used for the toilet doors and shall be brass finish. The make for these handles shall be enox, leme or equivalent make.
• All the doors on floor springs (both glass and solid) shall have brass-finished push/ pull plates as per the dwgs as handles.
• All locks shall be of solo, vijayan or equivalent make.
All the tower bolts shall be as per the specified length and shall be flora, magnum or equivalent make.
**POP AND GYMPSPUM WORK**

1. G.I. screws will be used for fixing of Plaster of Paris / Gypsum Sheets.

2. All the false ceiling, partition work & Gypsum sheet cladding work shall be as per Gypsum India or an equivalent prescribed norms and their specifications.

3. All 'Gypboard shall be of India Gypsum Company or equivalent make as per IS 2542: Part 2: Sec 1 to 10. It shall be fixed to the G. I. frame work and ply, jointed and finished with jointing compound, paper tape and finished with two layers of approved primer all as per Manufacturers Specifications ready to receive paint.

4. The Plaster of Paris used for the punning on the walls shall be the best quality as per IS 2333: 1992. All punning work shall be executed in perfect line and level and of smooth & even finish.

5. Rate of Plaster of Paris punning towels shall include necessary hacking of internal existing Neroo plaster.

6. The work will have to be executed at any height and lift will not form the criterion for any extra amount.

7. All the rates quoted shall be inclusive of the required scaffolding.

**GYPSUM WORKS**

1. **Metal Stud Partition**

Providing and fixing vertical partition above false ceiling level with necessary cut out as specified in architects/consultants drgs including one layer of 3mm thk commercial plywood and one layer of tapered edge 12.5mm thk Gypboard (conforming to IS-2095 - 1982) screw fixed with drywall screw of 25mm at 300mm centres to both sides of 48/70mm studs (0.55mm thick having equal flages of 32mm made of G.I.Steel) with joints staggered to avoid through joints. The partition will be acoustically treated by overlapping the GI framework with fibreglass sheets, TWIGA INSUL’ - IT - 1000 of 50mm thickness. Finally, square and tapered boards are to be jointed and finished so as to have a flush look which includes filling and finishing with jointing compound, paper tape and two coats of Gypboard Top coat suitable for Gypboard (as per recommended practices of India Gypsum or equivalent).

2. **M/F Suspended Ceiling Regular (Single Layer)**

M/F Suspended Ceiling which includes G.I. perimeter channels of size 0.55mm thick (having one flange of 20mm and another flange of 30mm and a web of 27mm) along with perimeter of ceiling, screw fixed to brickwall / partition with the help of nylon sleeves and screws, at 610mm centres. Then suspending G.I intermediate channels of size 45mm (0.9mm thick with two flanges of 15mm each) from the soffit with G.I. cleat and steel expansion fasteners Ceiling section of 0.55mm thickness having knurled web of 51.5mm and two flanges of 26mm each with lips of 10.5mm are then fixed to the intermediate channel with the help of connecting clip and in direction perpendicular to the intermediated channel at 457mm centres. 12.5mm tapered edge Gypboard (conforming to IS: 2095-1982) is then screw fixed to ceiling section with 25mm drywall screws at 230mm centres. Screw fixing is done mechanically either with screwdriver or drilling machine with suitable attachment. Finally the boards are to be jointed & finished so as to have a flush look which includes filling & finishing the tapered & square edges of the boards with jointing compound, joint paper tape and two coats of Drywall Top Coat suitable for Gypboard (as per recommended practices of India gypsum or equivalent).
3. **M/F Suspended Ceiling (3 hr. Fire Resistance)**

Providing & fixing 3 hr. fire resistant suspended ceiling which includes G.I. perimeter Channels of size 0.55mm thick having one flange of 20mm and another flange of 30mm and a web of 27mm along with perimeter of ceiling, screw fixed to brickwall / partition with the help of nylon sleeves and screws, at 610mm centres. Then suspending G.I. intermediate channels of size 45mm (0.9mm thick with two flanges of 15mm each) from the soffit at 900mm centres with M.S. flat of width 25mm x 3mm thick fixed of soffit with G.I. cleat and steel expansion fasteners. Ceiling section of 0.55mm thickness having knurled web of 51.5mm and two flanges of 26mm each with lips of 10.5mm) are then fixed to the intermediate channel with the help of connecting clips and in direction perpendicular to the intermediate channel at 457mm centres. 15.0mm tapered edge fireline board (conforming to IS: 2095 - 1982) is then screw fixed to ceiling section with 25mm drywall screws at 230mm centres. Screw fixing is done mechanically either with screwdriver or drilling machine with suitable attachment. After fixing first layer of Fireline board, second layer of 15.0mm tapered edge Fireline board is screw fixed with 45mm drywall screws at 230mm centre as above, but the joints are staggered to avoid leakage through joints. Then tapered & square Edges of the boards are filled & finished with jointing compound, joint paper tape suitable for Gypboards (as recommended by Indian Gypsum or equivalent make). Finally a layer of 12mm thickness of Base coat plaster (fire resistance) is applied with Expanded Metal 18 guage in centre for reinforcement followed by 2 coats of Drywall top coat (fire resistance) at the face of plaster to give smooth seamless finish.

4. **Metal Stud Partition (Double Layer)**

Providing & fixing 132mm thk. Metal Stud partition with 2 hrs. Fire resistance which includes two layer of tapered edge 15.0mm thick Fireline board screw fixed with drywall screw of 25mm for first layer & 45mm for second layer at 300mm centres to either side of 70mm studs (0.55mm thick having one flange of 34mm & another flange of 36mm made of G.I. steel) placed at 610mm centre to centre in 72 floor & ceiling channel) 0.55mm thick having equal flanges of 32mm made of G.I steel) with joint staggered on each layer to avoid leakage through joints. Finally the square and tapered edges of the boards are to be jointed & finished so as to have a flush look, which includes filling & finishing with jointing compound. Joint paper tape and two coats of Drywall Top Coat suitable for Gypboard (as per recommended practices of India Gypsum or equivalent)
SPECIFICATIONS FOR PLUMBING

1 BASIC MATERIALS AND METHODS

1.1 GENERAL

All materials shall be new and of the best of their kind and shall conform to the latest Indian Standard Specification.

All materials shall be approved quality as per samples and origins approved by the Architects/Consultants.

As and when required by the Architects/Consultants, the contractor shall arrange to test the materials and/or portions of the works at his own cost to prove their soundness and efficiency. If after tests any materials, work or portions of work are found defective or unsound by the Architects/Consultants, the contractor, shall remove the defective materials from the site, pull down and re-execute the works at his own cost to the satisfaction of the Architects/Consultants. To prove that the materials used are as specified, the contractor shall furnish to Architects/Consultants with original vouchers on demand.

All works executed shall be as directed and to the satisfaction of the Architects/Consultants.

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

Short or long bends shall be used on all main pipe lines as far as possible. Use of elbows shall be restricted for short connections.

Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

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

Clamps, hangers and supports on RCC walls, columns & slabs shall be fixed only by means of approved made of expandable metal fasteners inserted by use of power drills.

All pipes clamps, supports, nuts, bolts, washers shall be galvanized MS steel throughout the building. Painted MS clamps & nuts, bolts & washers shall not be accepted.

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

Access, doors for fittings and clean outs shall be so provided that they are easily accessible for repair and maintenance.

Sanitary appliances, subject to the type of appliance and specific requirements, shall be fixed in accordance with the relevant standards and the following:

a. Contractor shall, during the entire period of installation and afterwards protect the appliances by providing suitable cover or any other protection so as to absolutely prevent any damage to the appliances until handing over (The original protective wrapping shall be left in position for as long as possible)

b. The appliances shall be placed in correct position or marked out in order that pipe work can be fixed or partially fixed first.

c. The appliance shall be fixed in a manner such that it will facilitate subsequent removal if necessary.

d. The appliance shall be securely fixed. Manufacturer's brackets and fixing methods shall be used wherever possible. Compatible rust-proofed fixings shall be used. Fixing shall be done in a manner that minimize noise transmission.
e. Appliances shall not be bedded (e.g. WC pans, pedestal units) in thick strong mortar that could crack the unit (e.g. ceramic unit)

f. Pipe connections shall be made with demountable unions. Pipe work shall not be fixed in a manner that it supports or partially supports and appliance.

g. Appliances shall be fixed true to level firmly fixed to anchor or supports provided by the manufacturer and additional anchors or supports where necessary.

Contractor to take note of following points:

- The rate for each item included in the Schedule of Quantities shall include cost of Wastage on materials and labour.
- Supply of materials, fixing of materials, accessories, appliances and tools, plants, equipment, transport, labour and incidentals required for the entire execution, testing, balancing, commissioning and completion of work should be as per Specifications and Drawings.
- Pipe work shall not be fixed in a manner that it supports or partially supports an appliance.
- Appliances shall be fixed true to level firmly fixed to anchor or supports provided by the manufacturer and additional anchors or supports where necessary.

2.0 PLUMBING FIXTURES AND TRIM

2.1 SCOPE OF WORK

Work under this section shall consist of furnishing all materials & labor necessary and required to completely install all sanitary fixtures, chromium plated fittings and accessories as required by the drawings specified hereinafter and given in the Schedule of Quantities.

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

a) Sanitary fixtures
b) Chromium plated fittings
c) Porcelain or stainless steel sinks
d) Accessories e.g. towel rods, toilet paper holders, soap dish, towel rack, coat hooks etc.
f) Connections to all kitchen, pump headers and other equipment requiring water and drainage connections.

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

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

2.2 GENERAL REQUIREMENTS

Sanitary fixtures shall be of the best quality approved by the Architects/Consultants. Wherever particular makes are mentioned, the choice of selection shall remain with the Architects/Consultants.

All fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Schedule of Quantities, specifications and drawings. Accessories shall also include proper fixing arrangement, brackets, nuts, bolts, screws and required connection pieces.

Fixing screws shall be half round head chromium plated brass screws with C.P. washers where necessary.

Contractor shall furnish without cost all such accessories and fixing devices that are necessary and required but not supplied along with the Plumbing Fixtures & CP fittings by the manufacturers as a part of the original and standard supply.

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

Contractor should seal all fixtures fixed near wall, marble and edges with an approved type of polysulphide sealant appropriate for its application.

2.3 VITREOUS CHINA SANITARYWARE

All glazed Vitreous China Sanitary ware fixtures shall conform to Indian Standard IS: 2556. The details, make and type to be provided are given in the Schedule of Quantities. The Vitreous China Sanitary ware shall be of first quality only. They shall be non-porous and fully vitreous, with all the visible portions perfectly glazed and should absolutely be free from hairline cracks pin-holes and local depressions. It shall be perfectly symmetrical, uniform and smooth and curves. All sanitary fixtures and fittings shall be stored under covered roof and handled carefully to prevent any damage.

2.4 CHROMIUM PLATED FITTINGS

All Chromium plated fittings shall be of brass/copper, heavy chromium plated, of the make and design approved by the Architects/Consultants. The fittings shall be cast fittings of screw type, machined and threaded properly for fixing to the supply pipes.

The plating shall conform to Indian Standard IS:482 (Electroplated coating of nickel and chromium of copper and copper alloys).
The fittings shall be supplied complete with chromium plated matching flanges, wall cover plates, nuts and extension pieces of required lengths. Metallic washers where required shall also be of chromium plated brass. All bib cocks and stop cocks shall conform to Indian Standard IS:781. Brass screw down pillar taps shall conform to IS:1701 and all other fittings shall match the supply fitting in construction and appearance. All fixing accessories and screws shall be similar to fittings. All washers shall conform to Indian Standard IS:4346.

All waste fittings (Waste, Chain, Overflow, Spreaders Caps etc.) shall be of brass/copper heavy chromium plated of the make and design specified and match the supply fittings. They shall conform to Indian Standard IS:2963.

Bottle traps (for wash basins, sinks, urinals etc) shall be deep seal (Min. 6cm seal) cast brass bottle traps, heavy chromium plated. All bottle traps shall be provided with suitable cleaning eye, extension piece, flare nuts of all chromium plated.

Wall flanges shall be provided on all walls, floors, columns etc. wherever supply and disposal pipes pierce through them. These wall caps shall be of chromium plated brass snugly fittings and the receiving pipes and shall be large enough to cover the punctures properly.

2.5 INSTALLATION OF SANITARY FIXTURES AND FITTINGS

General Requirement

The fixtures and fittings shall be provided with all such accessories as are required to complete the item in satisfactory working conditions, whether specifically mentioned or not in the schedule of Quantities, Specifications and drawings.

The sanitary fixtures and fittings shall be installed at the correct assigned position as shown on the drawings and as directly by the Architects / Consultants, and shall fully meet with the aesthetic and symmetrical requirements as demanded by the Architects/Consultants.

All fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per Architects/Consultants requirements. Wherever necessary, the fittings shall be centered to dimensions and pattern as called for.

Fixtures shall be installed by skilled workman with appropriate tools according to the best trade practice. Manufacturer's instructions shall be followed for the installation of fixtures. Fixtures in all toilets shall be standard height mounting as called for on the drawings. Fixtures shall be mounted rigid, plumb, and true to alignment.

Mock up and Trial Assembly

The installation of the sanitary fixtures and fittings shall be as per the shop drawings approved by the Consultants.

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

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

Supporting and Fixing Devices
The contractor shall provide all the necessary supporting and fixing devices to install the sanitary fixtures and fittings securely in position. The fixing devices shall be rigidly anchored into the building structure. The devices shall be rust resistant and shall be so fixed that they do not present an unsightly appearance in the final assembly. Where the location demands, the Architects/Consultants may instruct the contractor to provide chromium plated or other similarly finished fixing devices. In such circumstances the contractor shall arrange to supply the fixing devices and shall be installed complete with appropriate vibration isolating pads, washers and gaskets.

**Final Installation**

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

Fixtures shall be mounted rigid, plumb and to alignment. The outlets of water closet pans and similar appliances shall be examined to ensure that outlet ends are butting 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 and settlement by other causes. Overflow shall be made to ensure that necessary anchoring devices have been provided for supporting water closets, wash basins, sinks and other appliances.

**Protection against damage**

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

**2.6 MEASUREMENT**

Sanitary fixtures and accessories shall be measured by numbers in the unit given in the Schedule of Quantities.

Rates for all items shall be inclusive of cutting holes and chases and making good the same, C.P Brass screws, nuts, bolts and any fixing arrangements required and recommended by manufacturers, testing and commissioning.

Note: All sanitary fixtures & CP fittings shall be supplied by client free of cost. Rate for installation shall remain good for the same.

**3 WATER STORAGE TANKS**

**3.1 GENERAL**

The following provisions should be made by the plumbing contractor in the Water Storage Tank

1. 600 dia opening with sealed manhole cover.
2. Manhole with double sealed manhole cover.
3. Inlets, outlets over flows, drains and insect proof vent cowls as required on Drawings.
Necessary perforations (including puddle flanges where required) for the inlet and outlet pipes shall be provided. Each storage tank shall be equipped with overflow, warning pipes, and vent pipes, and drain sumps (located directly below the manhole).

With watertight hinged cover and locking device.

3.2 TANK FITTINGS

A. Overflow pipes shall be:
   i) Dipped down inside tanks so as to terminate in a position maximum 150mm above bottom of pump room floor.
   ii) Provided with metal hinged flaps at outlets.
   iii) Discharge in conspicuous position.

B. Strainers with Anti-vortex Plate shall be:
   i) 3mm thick brass strainer
   ii) With 3mm thick galvanized mild steel anti-vortex plates
   iii) With total perforation area of 3mm maximum diameter holes not less than twice of the cross section area of pump suction pipe.

3.3 LEVEL CONTROLLERS

A. All level controllers, level sensors, level switches and alarms shall be provided and installed by the contractor.

B. Each probe shall be of the correct length for its particular application and tank location. Electrodes shall be polished stainless steel 20mm outside diameter. Electrode holders shall be weather proof in all respect.

C. The earthing probes shall be connected and wired to the building earth system.

D. Each set of electrodes shall be installed inside a 200mm-diameter PVC pipe acting as a wave barrier.

E. The level switch set shall be operated with a stepped down voltage at 24V maximum. Stepped down transformer shall be provided for each set of control probes and shall be installed inside centralized control cubicles inside pump room.

F. Provide interface unit at the pump control panel for the levels to be monitored by BMS (refer to drawing).

G. The BMS control panel will monitor the following outputs from the location for each Tank.
   - BMS Tank High Level (O/P)
   - BMS Tank Low Level (O/P)
   - BMS Level Sensing (O/P)

Whenever the liquid level in the tank reaches a high level, a high level dry contact will be provided by the contractor at the level controller and monitored by the BMS.
   - BMS Tank Low Level (O/P)
Whenever the liquid level in the tank reaches a low level, a low level dry contact will be provided by the contractor at the level controller and monitored by the BMS.
   - BMS Level Sensing (O/P)
The BMS will monitor the level of liquid in specified tanks via a level sensor provided by the M&E contractor. All level controllers will provide a 4-20mA signal to the ELV contractor.

3.4 EXECUTION

1. Tank Disinfection

   A. Disinfect all potable water tanks including concrete water tanks according to the following method:

   B. A solution of 200-mg/L available chlorine shall be applied directly to the surfaces of all parts of the storage facility that would be in contact with water when the storage facility is full to the overflow elevation.

   C. The chlorine solution may be applied with suitable brushes or spray equipment. The solution shall thoroughly coat all surfaces to be treated, including the inlet and outlet piping, and shall be applied to any separate drain piping such that it will have available chlorine of not less than 10mg/L when filled with water. Overflow piping need not be disinfected.

   D. The disinfected surfaces shall remain in contact with the strong chlorine solution for at least 30-min., after that entire water should be flushed out. After which potable water shall be admitted, the drain piping shall be purged of the 10-mg/L chlorinated water, and the storage facility shall then be filled to its overflow level. Following this procedure, and subject to satisfactory bacteriological testing and acceptable aesthetic quality, water may be delivered to the distribution system.

4. DOMESTIC WATER PUMPS

4.1 GENERAL

   a. The pump heads in the Schedules or Drawings are given for tendering guidance only and the Contractor shall be responsible for checking the total final resistance of each system, based on the actual pipe runs and equipment offered, prior to ordering. Any modifications to the system or any of the components, i.e. pumps, pipe work, motors etc., which may be required to meet the scheduled duties and space limitations shall be carried out at the Contractor’s expenses.

   b. All pumps shall be constructed to meet the required working conditions and test pressure of the system concerned.

   c. All pumps shall be self-primed and mounted on a common bed-plate together with the motor and directly driven through a flexible coupling and shall be aligned in the manufacturer’s factory. Locally fabricated bed-plates will not be accepted. Base plate shall incorporate a drain pan and is to be provided with a screwed socket outlet for drain connection.

   d. Unless otherwise specified, pumps shall be selected for an impeller speed of 1450/1500 rpm. All pumps shall be as commercially silent in operation. A unit which is considered to be noisy shall be removed from the site and replaced by silent unit at the Contractor’s expense.

   e. The Contractor shall submit for the approval the characteristic curves of the pump offered. The operating conditions shall be indicated and curves of pumps having excessive shut-off head will not be accepted.

   f. All pumps shall be fitted with an air-cock and drain plug. Each pump shall be provided with connection for pressure gauges at the suction and delivery connections, the gauges for all
pumps shall be mounted on common hardwood gauge board on the wall inside the pump room. Gauges shall have 100mm diameter dial. Pressure gauge piping shall be copper comprising a loop siphon at the junction to the gauge and each gauge shall be supplied through 12mm diameter brass pig tail and pet cock. Drains shall be piped to floor drains/waste pit.

g. The Contractor shall supply and install flexible pipe connectors at the pump suction and discharge sides for each pump.

h. All flexible connectors shall have flanges joints to the table specified for the connecting pipe work and must be suitable for the working conditions and test pressure of the system concerned.

i. Gland drains shall be provided in each pump packing gland with suitable nipple/outlet for copper/PVC pipes to be connected. All drains shall have a minimum internal bore of 15mm diameter and arranged in a proper pattern for piping the same to the channels or floor outlets provided inside the pump room.

j. Where necessary, an automatic air relief valve shall be fitted in the pump to purge any air likely to be trapped inside the pump casing. Suitable fittings shall be used for such connection and the relief valve shall not discharge at a location directly over or near to the pump motor or any other electrical equipment.

k. Each pump shall be fitted with valves to enable it to be isolated, and in addition, where shown on the Drawings, a check/non-return valve shall be fitted in each pump discharge.

l. Transfer pump set shall be mounted on an inertia block. Holding down bolts shall be set in position during the manufacture of the structural base. Filtered pump set shall be mounted on base plate. Generally, all pump sets shall be mounted on the reinforced concrete plinth 150mm high or as instructed by the Engineer.

m. Inertia block shall be concreted. Anchor bolts of base shall be provided.

n. Pump inertia bases shall be provided and shall be twice the operating weight of the pumps and the associated pipe work as mounted thereon.

o. The base plates shall be of approved make with pads machined for correct alignment of the pump and motor. At least two locating dowels shall be fitted to each component after alignment.

p. All exposed shafts, couplings and moving parts of pumps shall be provided with suitable galvanized angle iron wire mesh guards which shall be stoutly constructed and easily removable; and shall be provided with lifting handles. Care shall be taken that these guards of not cause "Ringing" sound and/or vibrate so causing noise.

q. An identification plate of metal shall be fixed to each pump unit. This plate shall include full details and diameter of the impeller installed, pump size, model and serial number, rpm, amps, etc. pump head and delivery for the duty specified, and lubricant required.

r. All pumps shall bear the manufacturer’s designation plate which shall indicate the type of services and serial number of the unit.
4.2 PUMP ARRANGEMENT

Pumps for plumbing services are single stage or multi-stage centrifugal vertical, horizontal split case or end suction type as shown in Schedule of quantity/ Drawing.

De water / Sewage pumps shall be submersible type, or centrifugal self priming.

Each pump shall be directly coupled with the electric motor and aligned in the manufacturer’s factory.

4.3 PUMP SPEED AND NOISE

Pumps shall be selected for an impeller speed as indicated in the Schedule/Drawing. All pumps shall be as commercially silent in operation.

The noise level shall be not more than NC 70 in pump room, NC 50 in the same floor and NC 35 for other floors.

4.4 PUMP BASES

Except for submersible sump pumps, each pump set shall be mounted on an anti- vibration pump base. Details shall be submitted by the Contractor well before the manufacture of the structural base. All holding down bolts shall be provided by the Contractor.

4.5 SAFETY GUARDS

All exposed shafts, couplings and moving parts of pumps shall be provided with suitable galvanized angle iron wire mesh guards which shall be stoutly constructed and easily removable; and shall be provided with lifting handles. Care shall be taken that these guards do not cause “ringing” sound and/or vibrate so causing noise.

4.6 IDENTIFICATION

An identification plate of metal shall be fixed to each pump unit. This plate shall include full details and diameter of the impeller installed, pump size, model and serial number, r.p.m., sumps, etc pump head and delivery for the duty specified, and lubricant required.

All pumps shall bear the manufacturer’s designation plate which shall indicate the type of services and serial number of the unit.

4.7 ELECTRICAL WORKS FOR PUMPS

All electrical works associated with the pumps shall comply with the NBC regulations (the latest edition) code of practice, supply rules and regulations and described in the relevant section of this Specification.

Anti-vibration mountings shall be inertia base, springs, neoprene pads or rubber-in-shear isolators, with the specified static deflection and selected to provide isolating efficiency of not less than 95%.

A. The control panel shall be of the pressure switch/microprocessor. The complete control panel assembly and all the internal devices shall be UL508. The panel shall be complete with IP54/NEMA1 enclosure and include door interlocked main disconnect and magnetic motor
starters with fused motor protectors, adjustable time delays, Hand-off auto selector switch and
for each pump, power on light, minimum run timers, low suction pressure switch and pilot light. The
control circuit shall include fault relay circuit to turn on the next pump should the lead
pump fail.

B. Should the duty pump fail to start and the pressure of the system shall continue to fail, the
standby pump shall be initiated to cut into operation.

C. Either pump shall be able to be selected as duty/standby/jockey. The operating pump shall
also be able to select as automatic or manual and interlock devices shall be provided to
isolated the system for maintenance

D. Automatic changeover shall be provided to alternate between the duty/standby pumps on
each cycle.

E. A time delay (0 to 10 seconds) switch shall be installed in the control of each pump set to
provide a time lag between the initiation of signals by the pressure switches (both pump on
and off) and the actual start and stop of the pump set to avoid excessively frequent on/off
cycles of the pumps due to surges in the long pipe runs.

F. The pump set together with the required control panel and fitted with hoot shall be mounted
on a common bedplate, factory assembled in the manufacturer's workshop prior to delivery.
Control panel for all pump sets shall be as per Indian standard.

4.8 RAW WATER PUMPS

Where required transfer water pumps shall conform to the following Specification:

Pump efficiency shall not be less than 70%,

Materials shall be as follows:

- Casing - Cast iron and minimum working pressure not less than 250 PSI
  or 150% of maximum discharge pressure.
- Impellers - Bronze and hydraulic balancing.
- Wearing - Bronze
- Rings
- Shaft Sleeve - Bronze
- Shaft - Stainless steel
- Seal - Mechanical seal/gland packing (asbestos-free)
- Couplings - Flexible metallic coupling, complete with coupling guards
- Bearings - Ball thrust type, grease lubricated, rated bearing life not less
  than 100,000 Hr

4.9 SUBMERSIBLE SEWAGE AND DRAINAGE PUMPS

Submersible sewage and drainage pumps shall be installed in sump pits consisting of discharge
connection, galvanized steel guide rail, galvanized chain and lifting handle as per detail. Pump
efficiency shall not be less than 40%. Can be handle solid particle upto 50mm.

Materials shall be as follows:
Casing  - High grade grey cast iron with internal sea water corrosion resistant coating

Impellers  - Cutter type for sewage pumps or non-clog type for drainage pumps, chromium-alloyed cast iron material of abrasion resistant.

Shaft  - Stainless steel.

Seal  - Double mechanical seal.

Bearings  - Ball thrust type, grease lubricated

Maximum  - As shown on the Equipment Schedule/Drawing speed

Bolt & Nut  - Stainless Steel

Level switches (high/low levels alarm and indications) shall be supplied and installed in the sump pits for the proper operation of the pumps as indicated on Drawings. The switches shall be of mercury float switch type. The lead-lag selection of pumps shall be changed automatically after each cycle.

Attention shall be paid to the internal dimensions of the sump pits and covers when selecting pumps.

Motor shall be class F insulation and inside the casing to prevent water ingress.

The Contractor shall supply and fix pump discharge pipe work, vents, control and power wiring and associated conduit. Three spare packing shall be provided for each pump.

The installations shall be complete with the following accessories:

- Seal monitor in oil chamber for leakage checking.
- Thermal switches to project over heated motor.
- Automatic control box.
- Cable of sufficient length for connection of the control box to the pump.
- A.C. alarm bells.
- Cable holders.

4.10 EXECUTION

A. Completely align and level pumps, motors and bases. Where pumps and motor are shipped as a unit, realign them in the field.

B. Grout base plates completely to provide a non-deflecting support.

C. Install and align mechanical seals in accordance with the manufacturer's recommendation.

D. Pump manufacturer or his represented to set packing, adjust impellers and check alignment prior to start-up.

E. Pump shall be mounted according to vibration isolation section.

F. Repair all surface damage during shipping and installation or prior to client’s acceptance of the building.
5. **INTERNAL & EXTERNAL WATER SYSTEM**

**GENERAL**

Water supply system to cater for drinking, washing, flushing & other requirements shall be installed as called for on the drawings.

The piping system consists of medium class galvanized iron pipes and fittings, CPVC/PPR Pipes or other material as called for. The size and makes are specified in the Schedule of Quantities.

5.1 **REQUIREMENTS**

A. Supply and installation of the cold water system including incoming water mains, all distribution pipe work, transfer pumps, multistage pressure booster pump sets, valves, fittings, hangers, equipment supporting frameworks, etc. as per the Drawings.

B. Water connections shall be provided at the plot boundary by Municipal Authority.

C. The incoming water mains shall be routed to water storage tanks in the vicinity. Water supply distribution system to various usage points will be through hydro-pneumatic system.

D. Water hose points shall be provided to the basement plant rooms, roof and other areas as required.

5.2 **FERRULES**

The ferrules for connection with C.I main shall generally conform to IS: 2692. It shall be of non-ferrous materials with a C.I bell mouth cover and shall be of nominal bore as specified. The ferrule shall be fitted with a screw and plug or valve capable of completely shutting off the water supply to the communication pipe, if and when required.

5.3 **WATER METERS**

Water meters of approved make and design shall be supplied for installation at location as shown. The water meters shall meet the requirement and approval of local water supply authorities. Suitable valves and chambers or wall meter box to house the meters shall also be provided along with the meters.

The water meters shall be provided with straight reading, dry dial, hermetically sealed register, and magnetic drive. The rotation of the turbine is directly transmitted to be register, and magnetic drive. The meters shall have totalization of flow volume in cubic meter (cum). The meter shall conform to local municipal authority, and shall be suitable for connection to the BMS for remote monitoring/reading.

The meters shall conform to Indian Standard IS: 779 and IS: 2373. Where called for, the water meters shall be located in masonry chambers of appropriate size.

Provision shall also be made to lock the water meter. The provision shall be such that the lock is conveniently operated from the top. Where the provision is designed for use in conjunction with padlocks, the hole provided for padlocks shall be a diameter not less than 4mm.

5.4 **MAKING WATER CONNECTION**

A pit of suitable dimension shall be dug at the point where the connection is to be made with ring main and earth removed up to 150mm below the main. The flow of water in main shall be disconnected by operating the nearest sluice valve on the main. The main shall be drilled and
slopped at 45 to the vertical and the ferrule of required size shall be screwed in. the ferrule shall be fitted in a manner so that no portion of projection of the shank shall be left projecting within the main into which it is fitted. Ferrule shall be non-ferrous material with a CI bell mouth cover and shall be of nominal bore as required.

5.5 INSTALLATION OF WATER METER AND STOP COCK

The GI lines shall be cut to the required lengths at the position where the meter and stop cock are required to be fixed. Then end of the pipe shall be threaded. The meter and stop cock shall be fixed in a position by means of connecting pipes, GI jam nut and socket etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed. And the meter is installed exactly horizontal or vertical in the flow line in the direction shown by the arrow 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.

5.6 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 water storage tanks and pipes shall first be filled with water thoroughly flushed out. The storage tanks shall be filled with water again and disinfecting chemical containing chlorine shall be added gradually while tanks are being filled to ensure thorough mixing. Sufficient chemical shall be used to give water a dose of 50 parts of chlorine to one million parts of water. If ordinary bleaching powder is used, the proportions will be 150gms of powder to 1000 liters of water. The powder shall be mixed with water in the storage tank. If a proprietary brand of chemical is used, the proportions shall be specified by the makers. When the storage tank is full, the supply shall be stopped and all the taps on the distributing pipes are opened successively. Each tap shall be closed when the water discharged begins to smell chlorine. The storage tank shall then be filled up with water from supply pipe and added with more disinfecting chemical in the recommended proportions. 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 for domestic purposes.

5.7 TESTING

a) All water supply system shall be tested to hydrostatic pressure test of at-least two and half time the maximum pressure but not less than 7kg/sq.cm. for a period of not less than 24hours. All leaks and defects in joints revealed during the testing shall be rectified and got approved at site.

b) Piping required subsequent to the above pressure test shall be resettled in the same manner.

c) System may be tested in sections and such sections shall be entirely resettled on completion.

5.8 SHIFTING OF EXCAVATED SURPLUS MATERIAL

Contractor shall make his own arrangement to shift the surplus excavated material within the site limits as directed by Engineer-in-charge.

5.9 PROTECTION AGAINST CORROSION

All embedded piping material and accessories shall be suitably protected against corrosion. All embedded GI pipes shall be wrapped throughout with 1mm thick fiberglass RP Tissue laid in bitumen with overlaps in joints and final coat of bitumen paint. Where GI pipes are laid under floors, trenches
etc shall be encased with 100mm thick fine sand all-round in additions to the protective coating as stated above.

5.10 LAWN HYDRANT

Lawn hydrants shall be of 25mm size unless otherwise indicated. All hydrants shall be provided with ball valves and nipple to receive hose pipes. Lawn hydrant valves shall be of approved make and design. Where called for lawn hydrants shall be located in masonry chambers of appropriate size.

5.11 MEASUREMENT

All pipes above ground shall be measured per linear meter (to the nearest cm) and shall be inclusive of all fittings e.g., coupling, tees, bends, elbows, unions, flanges and U clamps with nuts, bolts & washers fixed to wall or other standard supports.

Jointing as per procedure specified above.

Cutting holes, and chases in walls, floors, any pipe support required for pipes below ground & making good the same.

6 PIPING AND FITTING MATERIAL

6.1 PIPING SCHEDULE

1. Notes on Pipe work

a) All PVC pipes where installed in direct contact with concrete shall be wrapped with polythene tape/fibreglass tissue for protection.

b) All fittings for pipe work shall conform to the relevant IS Specification.

c) Where purpose made fittings are required, they shall also be generally in accordance with the relevant IS Standard.

4. All pipe work shall be free from burst, rust and scale and shall be thoroughly cleaned before erection. Open ends during the progress of work shall be blanked-off with purpose-made metal or plastic caps and the use of wooden plugs is forbidden. Should any stoppage in the circulation occur after the various systems have been put into operation, owing to non-compliance with this requirement, the Contractor shall rectify the matter at no extra cost to the Contract.

5. Pipes shall be installed with correct falls for venting and draining and attention shall be paid to neatness of installation, i.e., groups of pipes shall be accurately spaced and valves, joints, etc., symmetrically arranged. Where two or more pipes are visible and change direction together bends shall be struck from a common radius point. Adequate clearances shall be maintained in all cases, to allow for the application of the insulation materials and finishing.

6. The Contractor shall note the restricted space available in certain service ducts and the absolute necessary to ensure that all pipe work is installed in the correct sequence, manner and position to ensure that operation of all valves and maintenance is possible.

7. All reductions in pipe sizes shall be made using approved standard reducing fittings. Reducing bushes shall not be used without approval. Connections between lengths of pipes shall be made using standard fittings. Long threads must not be used.
8. All pipe work in pump rooms, plant rooms, and on roof level shall be installed with flanges or unions at intervals not exceeding 6m for ease of dismantling.

9. Changes in direction of pipes shall be made with long radius bends or elbows, as far as practicable. Under no circumstances shall pipes be bent without the use of fittings.

10. All pipe runs when not installed underground or in duct shall be concealed as far as possible by careful positioning or shall be chased into walls, laid in screed etc., or as directed by the Architect/Consultant.

11. All pipe work within the fire protected areas must be enclosed to satisfy the local municipal/fire authority requirements and such enclosures shall be supplied and installed by the Contractor.

12. Where pipes and rainwater outlets pass through roof slabs, the Contractor shall leave suitable openings during casting. The Contractor shall install the pipe, rainwater outlets, etc., taking into account the water proofing installation method as detailed by the Engineer.

13. Floor drains shall be installed in the same manner as rain water outlets. Openings will be formed in the slabs. Detailed dimensions and locations shall be supplied by the Engineer.

14. The Contractor shall locate all valves, traps, cleaning eyes, and similar items where they are easily accessible for operation, inspection, and maintenance.

2. Water Supply System

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description</th>
<th>Type of Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Potable water tank drains, overflows and warning pipes up to and including 65mm diameter.</td>
<td>CPVC/Galvanized Iron medium class.</td>
</tr>
<tr>
<td>2.</td>
<td>Incoming potable water pipe from Municipal authority.</td>
<td>CPVC/Galvanized Iron medium class</td>
</tr>
<tr>
<td>3.</td>
<td>External Potable cold water main distribution pipe</td>
<td>CPVC/Galvanized Iron medium</td>
</tr>
<tr>
<td>4.</td>
<td>Potable cold-water branch pipe</td>
<td>CPVC/PPR</td>
</tr>
</tbody>
</table>

3. Soil/Waste and Rain Water System

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description</th>
<th>Type of Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Rain water pipe above ground 50mm and above</td>
<td>Cast Iron Pipe to IS 3989/UPVC SWR SYSTEM.</td>
</tr>
<tr>
<td>2.</td>
<td>Rain water pipe below ground 80mm and above</td>
<td>RCC pipes NP2 class/HDPE/DWC (PE/PP)</td>
</tr>
<tr>
<td>3.</td>
<td>Waste water pipe above ground 50mm and above</td>
<td>Cast Iron Pipe to IS 3989/PVC SWR SYSTEM/UPVC Pipes.</td>
</tr>
<tr>
<td>4.</td>
<td>Waste water pipe below ground 50mm and above</td>
<td>Stoneware Pipes / UPVC Pipes/RCC Pipes NP2 class/HDPE/DWC (PE/PP)</td>
</tr>
</tbody>
</table>
6.2 PIPING SPECIFICATIONS

6.2.1 Galvanized Iron Pipes

The pipes shall be galvanized mild steel welded (ERW) or (HFW) screwed and socketed conforming to the requirements of IS: 1239. The Galvanizing shall conform to IS: 4736. The Zinc coating shall be uniform, adherent, reasonably smooth and free from imperfections such as flux, ash and drops inclusions, bare patches, black spots, pimples, lumpiness, runs, rust stains, bulky white deposits and blisters. The pipes and sockets shall be cleanly finished, well galvanized in and out and free from cracks, surface flaws, laminations and other defects. All screw threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the pipe.

The fittings shall be malleable cast iron as per IS: 1879 and comply with all the requirements that of pipes. The sizes of pipes and fittings are specified in the schedule of quantities.

6.2.2 UPVC PIPES

UPVC Pipes and fittings shall be heavy class manufactured to Indian Standard IS: 4985 (Specification for UPVC pipes & fittings). The Pipes shall be of desired working pressure as specified in the Schedule of Quantities. On delivery to site, the pipes and fittings shall be inspected for thickness, cracks etc. The pipes shall be stored in a sheltered roof as protection against direct sunlight.

6.2.3 CPVC Pipes

Chlorinate Polyvinyl Chloride (CPVC) Pipes and fittings shall be heavy class manufactured to international Standard with the CPVC compound shall conform to (NSF) certification for use in drinking /portable water. Pipes shall be of desired working pressure as specified in the Schedule of Quantities. On delivery to site, the pipes and fittings shall be inspected for thickness, cracks etc. The pipes shall be stored in a sheltered roof as protection against direct sunlight.

6.2.4 PPR Pipes

POLYPROPYLENE RANDOM (PPR) Pipes and fittings shall be PN20 class manufactured to international Standard with the material compound shall confirmed to (DIN) certification for use in drinking /portable water. Pipes shall be of desired working pressure as specified in the Schedule of Quantities. On delivery to site, the pipes and fittings shall be inspected for thickness, cracks etc. The pipes shall be stored in a sheltered roof as protection against direct sunlight.

6.2.5 DWC Pipes

DOUBLE WALL CORRUGATED (PE/PP) Pipes and fittings shall be SN4 class Non-Smooth External Annular Corrugated wall & Smooth Internal wall) Polyethylene Piping System for non-pressure underground Sewerage & Drainage Applications, manufactured to EN 13476-3 Standard with the material compound shall confirmed to (EN 13476-3) certification for use in drinking /portable water. Pipes shall be of desired working pressure as specified in the Schedule of Quantities. On delivery to site, the pipes and fittings shall be inspected for thickness, cracks etc. The pipes shall be stored in a sheltered roof as protection against direct sunlight.

6.2.6 CAST IRON PIPES & FITTINGS

Soil, Waste, Vent, Anti-Siphonage and Rainwater Pipes shall be cast Iron Pipes upto first inspection chamber and from first floor level. All pipes shall be straight and smooth and inside free from irregular bore, blow holes, cracks and other manufacturing defects. Pipes shall be either of sand cast to IS: 1729 or centrifugal cast to IS: 3989.
6.2.7 Fittings

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

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

Access door shall be made up with 3mm thick insertion rubber washer and white lead. The bolts shall be lubricated with grease or white lead for easy removal. Fixing shall be air and water tight.

6.2.8 PVC SWR SYSTEM

PVC SWR systems for soil, waste & rain water shall be of manufactured to Indian Standard 13592. The pipes and fittings shall be of the rubber ring joints type with in-built groove for insertion of rubber seal lubricant. The rubber ring shall conform to IS: 5382. The Pipes shall be of desired working pressure as specified in the Schedule of Quantities. On delivery to site, the pipes and fittings shall be inspected for thickness, cracks etc. The pipes shall be stored in a sheltered roof as protection against direct sunlight.

6.3 PRESSURE RATING

The pressure rating of all pipes from cistern water tanks to the elevated water tanks shall be PN12.5. For all other pipe works, pressure rating shall be PN10 unless otherwise specified.

The pressure rating of valves and fittings shall be not less than that of the pipe work.

6.4 EXECUTION

1. The execution of works and materials used shall be as per the latest relevant I.S. specification. Whether reference has been made to Indian Standard or any other specifications, the same shall mean to refer to the latest specification irrespective of any particular edition of such specification being mentioned in the specifications below or Schedule of Quantities.

2. All pipes shall be anchored as required to control the movement of pipes due to thermal changes. Generally anchors shall also be fitted at the lower end of vertical pipes. Details of all anchor points shall be submitted to the Engineer for approval.

3. The anchors shall securely hold the pipe in a rigid position to resist the attempted movement due to expansion and the weight of pipe and contents.

2. The Contractor shall submit full details to the Engineer of all expansion and anchor joints proposed for use throughout the building prior to installation.

5. General

a) In all pipe system, long radius bends and pitcher tees shall be used wherever possible and practicable. All fittings shall be suitable for a working and test pressure not lower than that specified for the pipe work system concerned elsewhere in this Specification.

b) Reduction in bore of pipe shall be generally made eccentric for horizontal pipes (to prevent air locking) and concentric taper fittings shall be fitted for vertical pipes unless specifically required to achieve the required space and invert levels.

c) The workmanship shall be best of its kind and shall conform to the specifications, as below or Indian Standard Specifications in every respect or latest trade practices and shall be subject to
approval of the Architects/Consultants. All materials and/or Workmanship which in the opinion of the Engineer is defective or unsuitable shall be removed immediately from the site and shall be substituted with proper materials and/or workmanship forthwith.

d) Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

e) Pipes shall be securely fixed to walls and ceilings by suitable clamps at interval specified.

f) Clamps, hangers and supports on RCC walls, columns & slabs shall be fixed only by means of approved made of expandable metal fasteners inserted by use of power drills.

g) All pipes clamps, supports, nuts, bolts, washers shall be galvanized MS steel throughout the building. Painted MS clamps & nuts, bolts & washers shall not be accepted.

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

i) Tender drawings indicated schematically the size and location of pipes. The Contractor, on the award of the work, shall prepare detailed working drawings, showing the cross-section, longitudinal sections, details of fittings, locations of isolation and control valves, drain and air valves, and all pipe supports. He must keep in view the specific openings in buildings and other structures through which pipes are designed to pass.

j) Piping shall be properly supported on, or suspended from, on stands, clamps, hangers as specified and as required. The contractor shall adequately design all the brackets, saddles, anchor, clamps and hangers, and be responsible for their structural stability. All pipes shall be secured at every joint.

k) Piping supports shall be steel, adjustable for the height and primer coated with rust prevent paint and finish coated black. Where pipe and clamps are of dissimilar materials, spacing b/w the supports shall not exceed the following:

<table>
<thead>
<tr>
<th>Pipe size</th>
<th>Spacing between supports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 12mm</td>
<td>1.5 meters</td>
</tr>
<tr>
<td>15mm to 25mm</td>
<td>2.0 meters</td>
</tr>
<tr>
<td>30mm to 50mm</td>
<td>2.0 meters</td>
</tr>
<tr>
<td>Above 50mm</td>
<td>2.5 meter</td>
</tr>
</tbody>
</table>
l) Vertical risers shall be parallel to walls and columns 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 and with a 15mm thick rubber pad or any resilient materials. Where pipes pass through the terrace floor, suitable flashing shall be provided to prevent water leakage. Riser shall have a suitable drain out in the valve at the lowest point and air vent at the highest point.

m) Pipe sleeves, 50mm larger diameter than pipes, shall be provided wherever pipes pass through walls and slabs, and annular space filled with fiberglass and finished with retainer rings.

n) Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. 14gauge metal sheet shall be provided between the insulation and the clamp, saddle or roller, extending at least 15cm. on both sides of the clamps saddles or roller.

o) All pipe work shall be carried out in a workman like manner, causing minimum disturbance to the existing services, buildings, roads and structure. The entire piping work shall be organized in consultation with other agencies work, so that area shall be carried out in one stretch.

p) Cut-outs in the floor slab for installing the various pipes area are indicated in the drawings. Contractor shall carefully examine the cut-outs provided and clearly point out wherever the cut-outs shown in the drawings do not meet with the requirements.

q) The contractor shall make sure that the clamps, brackets, saddles and hangers provided for pipe supports are adequate. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.

r) All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burrs removed before lying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter.

s) Where reduces are to be made in horizontal runs, eccentric reduces shall be used for the piping to drain freely in other locations, concentric reduces may be used.

r) Flanged inspection pieces, 1.5meters long, with bolted flanges on both ends, shall be provided not more than 30meter centers wherever shown in approved for construction shop drawings to facilitate future cleaning of all welded pipes.

u) Insulation
   Hot water pipe lines in chase shall be insulated by wrapping 6mm thick asbestos rope around the pipe and finished with a coat of magnesia cement containing 85% magnesia.

v) Fixing Ferrules
   For fixing ferrule, the empty main shall be drilled and tapped at 4-5 to the vertical and the ferrule screwed in. The ferrule must be so fitted that no portion of the shank shall be left projecting within the main into which it is fitted.

w) Cutting Chases in Masonry Walls
   The chases up to 7.5x7.5cm shall be made in the walls for housing GI pipes etc. These shall be provided in correct positions as shown in the drawings or directed by the
Architects/Consultants. Chases shall be made by chiseling out the masonry to proper line and depth. After GI pipes etc are fixed in chases, the chases shall be filled with cement mortar 1:2:4 or as specified may be made flush with the masonry surface. The concrete surface shall be roughened with wire brush to provide a key for plastering.

6.5 PIPE INSTALLATION

Laying and Jointing of GI Pipes

All pipes and fittings shall be fixed truly vertical and horizontal unless unavoidable. The pipes shall be fixed to walls with standard slotted angles ‘U’ shape threaded bolts, nuts for clamping pipes to angles. Slotted angles shall be grouted to RCC work with dash fasteners of size so as to fit tightly on the pipes when tightened with screwed bolts. These slotted angles shall be spaced at regular intervals in straight lengths and heights.

The galvanized pipes and fittings shall run in wall chase or ceiling or as specified. The fixing shall be done by means of standard pattern holder bat clamps keeping the pipes about 1.5cm clear of the wall where to be laid on surface. Where it is specified to conceal the pipes, chasing may be adopted or pipes fixed in the shafts, ducts etc, provided there is a sufficient space to work on the pipes with usual tools. As far as possible, pipes may be buried for short distances provided adequate protection is given against damage and where so required special care to be taken at joints. Where directed by the Architects/Consultants, pipe sleeves shall be fixed at a place where the pipe is passing through a wall or floor reception of the pipe and allow freedom for expansion and contraction and other movements. In case of pipe is embedded in walls or floors, it should be painted with anticorrosive bitumastic paints of approved quality. Under the floors, the pipes shall be laid in layer of sand filling.

Galvanized iron pipes shall be jointed with threaded and socket joints, using threaded fittings. Care shall be taken to remove any burr from the end of the pipes after threading. White lead or an equivalent jointing compound of proprietary make shall be used, according to the manufacturer’s instructions, with a grummet of a few strands of fine yarn while tightening compounds containing red lead shall not be used because of the danger of contamination of water. Any threads exposed after jointing shall be painted with bituminous paint to prevent corrosion.

Laying and Jointing of UPVC Pipes

UPVC pipes and fittings shall be jointed using solvent cement. It is recommended to use formulated heavy duty solvent cement supplied by the company for trouble free performance of the system.

The jointing procedures are as follows:

Cut the pipe square to the required length by cutter.
Chamfer the cutting edges.
Insert the pipe into the fitting and check to that the interface occur about 1/3rd to 2/3rd of the socket depth.

Remove any dirt, moisture or grease from pipe end and fitting sockets with clean dry rag.

Roughen the contacting surfaces.

Application of solvent cement – Apply cement lightly but uniformly to inside of socket and outside of pipe end with suitable applicator.

Immediately after applying the last coat of cement to the pipe and while the cement is still fluid or wet, forcefully bottom the male end of the pipe in the socket, giving pipe or fitting ¼ turn (but not after pipe is bottomed) to distribute the cement evenly. Remove excess cement from the end of the fitting socket. The joint must not be disturbed immediately after cementing so that the joint can be properly cured.

**Laying and Jointing of CPVC Pipes**

CPVC pipes and fittings shall be jointed using solvent cement. It is recommended to use formulated heavy-duty solvent cement supplied by the company for trouble free performance of the system.

The jointing procedures are as follows:

Cut the pipe square to the required length by cutter.

Chamfer the cutting edges.

Insert the pipe into the fitting to check that the interface occur about 1/3rd to 2/3rd of the socket depth.

Remove any dirt, moisture or grease from pipe end and fitting sockets with clean dry rag.

Roughen the contacting surfaces.

Application of solvent cement. – It is recommended that to use Only CPVC cement or all-purpose cement conforming to ASTM F-493 for pipe jointing. Apply cement lightly but uniformly to inside of socket and outside of pipe end with suitable applicator.

Immediately insert the tubing into fitting socket, rotating the tubing 1/4” to ½” turn while inserting. This motion ensures an even distribution of cement within the joint. Properly align the fitting. Hold the assembly for approximately 10 seconds, allowing the joint to set-up. An even bead of cement should be evident around the joint. Wipe excess cement from the tubing and fitting surfaces.

**Installation of PPR**

Prior to installations site will be checked for the accessibility. Also Co-ordination will be done with other services at the time of marking.

Determine the position of supports and install the supports as per the approved standard detail drawings.

The water supply piping system is polypropylene (PPR) pipes system and & joints are to be fusion welded, electro welded type.

Every change in directions of the pipes, supports shall be provided with in 150mm on both sides, irrespective of distance mentioned in the standard detail drawing.
The polypropylene pipes and fittings will be joined by fusion jointing method, in which two pieces of pipes and fitting are heated by a heating tool until their surface melt, and then they are fitted together.

The 16mm to 63mm pipes and fittings are fusion jointed by hand held fusion tool. The 75mm to 110mm diameter pipes are joined by bench mounted fusion machines.

The fusion tool is plugged into an 110V supply and allowed to heat up for about 5 minutes. The temperature is checked using a temple stick which melts at 253°C temperatures.

The surface of the pipe and internal surface of the fittings are cleaned by a moist cloth with cleaning fluid, as per manufacturer recommendation.

The pipe must be cut at right angles using pipe cutters. Shears are used for 16mm to 25mm pipe diameter and roller cutters are used for pipe of 25mm to 63mm diameter, after this process chamfering will take place.

Mark the welding depth at the end of the pipe with the enclosed pencil and template.

The pipe and fitting are pushed simultaneously on to the heating bushes. Then their surface comes in contact with heating plate they will start to melt.

The insertion mark must be seen all the time during melting process. The fitting is pushed on to the heating bush until it reaches the first ridge on the bush.

The timer is then started when pipe and fittings are fully inserted. Then the timer beeps withdraw the pipe and fitting quickly and align pipe and fitting after bringing them together.

It is important to bring the pipe and fitting together quickly to prevent their surface cooling and drying. The molten pipes and fittings should be aligned together without any twisting.

The pipe is pushed into fitting upto insertion mark. After jointing one bead of molten material is formed on pipe and another bead on the fitting. This demonstrates a perfect joint.

All valves will be installed as per approved shop drawings.

Ensure all valves, strainers and inline fittings orientation is correct.

**Pipe Cleaning**

a) Upon completion of the domestic water system, disinfect this system, including water service connections, with chlorine in accordance with local practice.

The water storage tanks and pipes shall first be filled with water thoroughly flushed out. The storage tanks shall be filled with water again and disinfecting chemical containing chlorine shall be added gradually while tanks are being filled to ensure thorough mixing. Sufficient chemical shall be used to give water a dose of 50 parts of chlorine to one million parts of water. If ordinary bleaching powder is used, the proportions will be 15gms of powder to 1000 liters of water. The powder shall be mixed with water in the storage tank. If a proprietary brand of chemical is used, the proportions shall be specified by the makers. When the storage tank is full, the supply shall be stopped and all the taps on the distributing pipes are opened successively. Each tap shall be closed when the water discharged begins to smell chlorine. The storage tank shall then be filled up with water from supply pipe and added with more disinfecting chemical in the recommended proportions. 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 for domestic purposes.

b) All valves, after they have been disinfected, shall be opened and closed several times during the eight-hour period. Disinfection shall be repeated until piping meets the local bacteriological test criteria.

c) All other piping systems shall be flushed free of foreign matter with clean water and left with strainers clean upon completion of the work.

6.6 HANGERS, SUPPORTS, ANCHORS AND GUIDES

Provide hangers of heavy construction suitable for the size of pipe to be supported. All materials to be of hot dipped galvanized steel (touch up all cut ends with galvanized paint) except rollers which are to be of wrought or malleable iron. Hangers for pipes up to and including 125mm to be adjustable swivel ring, split ring, wrought pipe clamp, or adjustable wrought clevis type.

Support vertical piping with double bolt riser clamps attached to the pipe, resting on pre-engineered spring hanged attached to the floor slab. Use one clamp at every floor. Where pipes are in open shafts, provide forged steel bar brackets fixed to wall.

The following tables will establish a minimum level of acceptance for pipe hangers, supports and attachments.

A. Hangers and Supports

<table>
<thead>
<tr>
<th>Service</th>
<th>Hanger Type</th>
<th>Maximum Pipe Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Un-insulated PVC</td>
<td>Clevis</td>
<td>300mm</td>
</tr>
<tr>
<td>Un-insulated Copper</td>
<td>Clevis</td>
<td>300mm</td>
</tr>
<tr>
<td>Copper Pipe</td>
<td>Riser Clamp</td>
<td>150mm</td>
</tr>
<tr>
<td>All Insulated</td>
<td>Full Clamp &amp; Insulation Shield</td>
<td>600mm</td>
</tr>
<tr>
<td>All</td>
<td>Trapeze</td>
<td>600mm</td>
</tr>
<tr>
<td>All</td>
<td>Wall Bracket</td>
<td>125mm</td>
</tr>
<tr>
<td>All</td>
<td>Wall Bracket</td>
<td>300mm</td>
</tr>
</tbody>
</table>

B. Structure Attachments

<table>
<thead>
<tr>
<th>Type</th>
<th>Maximum Rod Size</th>
<th>Maximum Pipe Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam Clamp</td>
<td>20mm</td>
<td>200mm</td>
</tr>
<tr>
<td>Beam Clamp</td>
<td>40mm</td>
<td>600mm</td>
</tr>
<tr>
<td>Side Mount Clamp</td>
<td>20mm</td>
<td>200mm</td>
</tr>
<tr>
<td>Channel Clamp</td>
<td>20mm</td>
<td>200mm</td>
</tr>
<tr>
<td>Expansion Shield</td>
<td>20mm</td>
<td>200mm</td>
</tr>
</tbody>
</table>

C. Job or site fabricated products will not be allowed.
Execution

A. Provide hanger rod sizes in accordance with the following schedule:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Rod Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>25mm and smaller</td>
<td>10mm</td>
</tr>
<tr>
<td>32mm to 50mm</td>
<td>10mm</td>
</tr>
<tr>
<td>65mm to 80mm</td>
<td>15mm</td>
</tr>
<tr>
<td>100mm to 125mm</td>
<td>15mm</td>
</tr>
<tr>
<td>150mm</td>
<td>20mm</td>
</tr>
<tr>
<td>200mm to 300mm</td>
<td>25mm</td>
</tr>
<tr>
<td>350mm to 400mm</td>
<td>25mm</td>
</tr>
<tr>
<td>450mm</td>
<td>30mm</td>
</tr>
<tr>
<td>500mm</td>
<td>35mm</td>
</tr>
<tr>
<td>600mm</td>
<td>40mm</td>
</tr>
</tbody>
</table>

B. Provide hangers in accordance with the following schedule:

<table>
<thead>
<tr>
<th>Piping Material</th>
<th>Pipe Size</th>
<th>Maximum Hanger Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>35mm &amp; less</td>
<td>1800mm</td>
</tr>
<tr>
<td>Copper</td>
<td>42mm &amp; larger</td>
<td>3000mm</td>
</tr>
<tr>
<td>UPVC</td>
<td>50mm &amp; larger</td>
<td>1350mm</td>
</tr>
<tr>
<td>GI</td>
<td>50mm &amp; less</td>
<td>2000mm</td>
</tr>
<tr>
<td>GI</td>
<td>65mm &amp; larger</td>
<td>2500mm</td>
</tr>
</tbody>
</table>

C. Provide hangers at each change in direction on both sides of each valve and on both sides of cast iron pipe fittings.

D. For flat slab construction only, support hangers from concrete inserts. Furnish, locate and set such inserts and make sure that such inserts are in place when the concrete is poured. Construct inserts of malleable iron or pressed steel with space for rods of all sizes. Install all inserts for pipes 80mm and larger in size with a reinforcing rod 15mm in diameter run through a slot in the insert specifically provided for this purpose.

E. For flat slab construction only, if any pipe is to be hung in a space where no inserts have been provided, drill holes in the slab (subject to the Engineer prior approval) and provide rods and hanger attached to an approved fishplate or install double expansion shields connected by a 50mm x 50mm angle, from which the hanger rod is to be suspended. For pipe size 50mm and under, use single shields but the hanger spacing defined herein before to be reduced to 1.5m. The carrying capacity and
F. Size of each shield to be calculated on the basis of the spacing indicated above but the minimum size to be 10mm. Install additional shields of the same size so that the number of hangers are of adequate size to support the loads which they carry. Shields may be used in flat concrete slabs only.

G. Regardless of the type of construction (i.e., concrete, concrete-deck-steel or other variations) take particular care to support all main lines and all large and heavy pipes in an approved manner, including the furnishing and installation of supplementary steel, if required. Supplementary steel sections are to be mill-rolled. Submit shop drawings, indicating support methods, point loadings to the building structure and hanger locations for review sufficiently in advance of concrete pouring schedules to permit evaluation, critique and any necessary changes to handling and support methods.

H. Set all inserts for all pipes in ample time to allow concrete work to be performed on scheduled time.

I. Hangers may be directly attached to steel beams of building construction, where they occur, if approved by Engineer. Smaller pipes may be suspended from crosspieces of pipe or steel angles, which in turn, are to be securely fastened to building beams. The intention is to provide supports which, in each case, will be amply strong and rigid for the load, but which will not weaken or unduly stress the building construction.

J. Provide approved roller support, floor stands, wall brackets, etc., for all lines running near the floor or near walls, which can be properly supported or suspended by the floors or walls. Pipelines near walls may also be hung by hangers carried from approved wall brackets at a level higher than the pipe.

K. Do not hang piping from other piping. Support of hangers by means of vertical expansion bolts is not permitted.

L. Anchor piping as required to localize expansion or to prevent undue strain on piping and branches. Anchors to be entirely separate from hangers. All anchor designs to be submitted flex bellows flanged or screw type for approval and to include piping reactions which respective anchors are capable of supporting. Provide all indicated or required expansion loops.

M. Support all lines of copper tubing individually by approved type hangers not more than 2m apart, or as shown on the drawings. Use hangers especially designed for copper tubing and of exact outside diameter of tubing. On hangers for covered tubing, use broad straps fitting outside of covering.

N. Hangers used for cold piping will support the pipe without piercing the insulation. Use insulation shields to protect the insulation on cold pipes. Weld insulation protection saddles to insulated hot pipes, or any piping subject to axial movement, at roller supports. Space between pipe and saddle to be filled with insulation.

O. For piping 100mm and larger, support the elbows of the piping adjacent to the pumps with steel base elbow supports from the inertia base which pump is on to prevent loading heavy weights of piping on pump casing. Where inertia base is not provided, base elbows to be supported on floor with 25mm neoprene pad.

P. All pipes supports shall be of such design and type to allow for the removal of any pipe section without the necessity of disconnecting other adjacent pipes.
Q. In all plant and pump rooms discharge pipe work from pumps, and all pipe work where vibration could be transmitted to the building structure, shall be supported with brackets having a tough rubber lining in contact between the bracket and the pipe shall have anti-vibration hangers/supports.

R. Special attention shall be paid to that adequate pipe anchors shall be provided at the ends or turning points of UPVC/PPR pipes to prevent fracture of the pipe resulted from water hammer. Such anchor points shall be fixed in a manner that the inertia in the flow will be directly transmitted onto the anchors thus releasing the UPVC/PPR pipes from being under stress.

S. Where pipes pass through walls, floors, etc., the Contractor shall provide pipe sleeves. Sleeves for UPVC/PPR pipes & copper pipes shall be galvanized steel. For pipes, where sleeves are fitted through floors/wall they shall extend to at least 20mm clear stud out from the finished floor level.

T. The space between pipe sleeves and the pipe or insulation shall be completely backfilled with materials having the same fire resistant rating as the walls and floors by the Contractor. Should multi-services or more than one single pipe be laid through box-out, the space between the individual pipe sleeves shall be sealed off. The space between the pipe sleeves and the service pipes shall be back-filled.

U. Sleeves shall be of sufficient size to allow free movement of pipes and furthermore where pipes are insulated the sleeves shall be oversized to allow the insulation to be carried through the sleeves. The Contractor's attention is drawn to the vertical pipe ducts at all floor levels. Where pipes pass through floors, sleeves shall be provided. The Contractor shall supply sleeves for setting in walls, floors, etc., and in the shuttering before concrete is poured.

V. Details of pipes through walls and floors shall be approval by the Engineer before installation.

W. Where pipes pass through flat roofs covered with roofing material: -

   a) Cast or build in galvanized mild steel sleeve with 2 to 12mm clearance projecting 150mm above roof finish.

   b) Caulk space and point both ends with approved sealant.

   c) Cover tops of sleeves with lead collars as per roofing Specification.

6.7 VALVES

General

A. The Contractor shall supply and install all valves as indicated on the drawings and as required for the proper and efficient operation and maintenance of the entire systems.

B. All valves supplied shall be suitable for the working pressure and test pressure of the various water supply systems.

C. All valves other than automatic control valves shall be full line size.

D. Each valve shall have a purpose made reference number plate or label engraved or stamped indicating the manufacturer's catalogue number, pressure and temperature ratings. Valves shall be arranged so that clockwise rotation of the spindle will close the valve. Demo labels are not acceptable.

E. Furnish all valves and accessory material necessary in the piping whether or not shown on drawings as follows.
F. All valves shall be packed with an approved packing and threads shall be coated with oil and graphite. Packing should be replaced when found deteriorated on site.

G. Where possible locate all valves at convenient positions of operation from the floor with valve stems upright.

H. Valves that are flanged shall have flanges comply with BS 4504 as for pipe work.

I. Provide valves of the same manufacturer throughout, where possible.

J. All valves shall be with screwed or flanged ends as required by the piping system in which they are installed.

K. Valves shall be selected for the working pressure required.

L. Plastic or metal plates (rust-less) shall be provided to indicate the open/close status as well as the use of each valve in the pump and tank rooms, and in the town main.

Valves & Controls - Specifications

All valves (gate, globe, ball, check, and safety) shall be of gun metal non rising spindle valves suitable for the particular service as called for. All valves shall be of the particular duty and design as called for. Valves shall either be of screwed type or flanged type, with suitable flanges and non-corrosive bolts and gaskets. Tail pieces as required shall be supplied along with valves. Gate, globe and check valves shall conform to Indian Standard IS:778 and non-return valves to swing check type reflux to IS:5312.

Sluice valves, where called for shall be flanged sluice valves of cast iron body. The spindle, wall seat and wedge nuts shall be gunmetal. They shall generally have non-rising spindle and shall be of the particular duty and design called for. The valves shall be supplied with suitable flanges, non-corrosive bolts and asbestos fiber gasket. Sluice valve shall conform to Indian standard IS:780 and IS:2906.

Ball valves with floats to be fixed in storage tanks shall consist of cast brass lever arm having copper balls (26 SWG) screwed to the arm integrally. The copper ball shall have bronze welded seams. The closing/opening mechanism incorporating the position and cylinder shall be non-corrosive metal and include washers. The size and construction of ball valves and float shall be suitable for desired working pressure operating the supply system. Where called for brass valves shall be supplied with brass hexagonal back-nuts to secure them to the tanks and a socket to connect to supply pipe.

<table>
<thead>
<tr>
<th>Type of Valve</th>
<th>Size</th>
<th>Contraction</th>
<th>Ends</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) G.M valve</td>
<td>15mm to 50mm</td>
<td>Gun metal</td>
<td>Screwed</td>
</tr>
<tr>
<td></td>
<td>50mm and above</td>
<td>Gun metal</td>
<td>Flanged</td>
</tr>
<tr>
<td>b) Sluice valve &amp; butterfly valve</td>
<td>65mm and above</td>
<td>Cast iron/ iron</td>
<td>Flanged</td>
</tr>
<tr>
<td>c) G.M Non return valve</td>
<td>15mm to 50mm</td>
<td>Gun metal</td>
<td>Flanged</td>
</tr>
<tr>
<td></td>
<td>50mm and above</td>
<td>Gun metal</td>
<td>Flanged</td>
</tr>
<tr>
<td>d) Flap type Non return above</td>
<td>65mm and above</td>
<td>Cast iron</td>
<td>Flanged</td>
</tr>
</tbody>
</table>

Execution

A. All valves shall be installed only in the upright vertical or horizontal positions unless specifically otherwise required by the drawings.
B. All valves shall be installed in accessible locations to facilitate easy removal for repair or replacement.

C. Install with operating clearance for handle and stem.

D. Install isolation valves on equipment so that valve and piping do not interfere with equipment removal or maintenance. Install unions or flanges on equipment side of valves.

E. Provide 25mm drain valves with threaded ends for hose connections at drain points, at main shutoff valves, low points of piping systems, bases of vertical risers, and at equipment.

F. Provide required manual or automatic vent valves at high points of piping systems to facilitate venting of air and to ensure quiet operation.

G. Provide renewable bronze seat rings and bronze spindles for cast iron body valves.

H. Provide chain operated sheaves and chains for all valves which are more than 2.5m above the floor in Mechanical Equipment Rooms.

I. Furnish and install other valves, check valves, cocks, etc., as required for the complete and proper valving of the entire installation.

J. Install butterfly valves in horizontal piping with stem in the horizontal position so that bottom of disk lifts in the direction of flow.

K. Install butterfly valves in vertical piping at pumps with stem perpendicular to pump shaft.

6.8. STRAINERS

A. Strainers shall be installed in all pump suction and tanks.

B. Strainer under 65mm dia shall be pipeline Y-type strainer. Strainer of 65mm or above shall be of vertical (bucket) type, cast iron body with flanged connectors.

C. Strainer mesh shall be stainless steel 316 with filtering area of at least three times the sectional area of the pipe inlet.

6.9. FLEXIBLE CONNECTOR

A. Flexible connectors shall be of synthetic fiber reinforced rubber, twin sphere type for flush water and 316 stainless steel bellow type for type fresh water system. Details shall be submitted to the Architect at the time of tender.

B. Pressure rating of the flexible connectors shall be the same as the system pipe work unless otherwise noted on drawings.

C. Flexible connectors shall be installed at where shown on drawings and at all pump suction and discharges. The materials of the flexible connectors shall be suitable for the substances to be conveyed.
7 EXTERNAL DRAINAGE (SOIL, WASTE & RAINWATER)

7.1 SCOPE OF WORK

Work under this section shall consist of furnishing all labor, materials, equipments and appliances necessary and required to completely install the drainage system as required by the drawings and specified hereinafter or given in the schedule of quantities.

Without restricting to the generality of the foregoing, the drainage system shall include:-

Sewer Lines including excavations, pipe lines, manholes, drop connection and connections to the municipal or existing sewer, underground storm water drains, including pipes, manholes, catch basins and drop connections.

7.2 GENERAL REQUIREMENTS

All materials shall be new of the best quality conforming to specifications and subject to the approval of Consultants.

Drainage lines shall be laid to the required gradients and profiles.

All drainage work shall be done in accordance with the local municipal bye-laws.

Contractor shall obtain necessary approval and permission for the drainage system from the Municipal or any other competent authority.

Location of all manholes, catch basins etc. shall be got confirmed by the Architect/Consultants before the actual execution of work at site.

All works shall be executed as directed by Consultants.

All pipe lines shall be subjected to testing as per specification.

7.3 ALIGNMENT AND GRADE

The Sewer and Storm water drainage pipes shall be laid to alignment and gradient shown on the drawings but subject to such modifications as shall be ordered by Architect/Consultants from time to time to meet the requirements of the works. No deviations from the lines, depths of cutting or gradients of sewers shown on the plans and sections shall be permitted except by the express direction in writing of Architect/Consultants.

7.4 EXCAVATION

The Excavation for Sewers works shall be open cutting unless the permission of Architect/Consultants for the ground to be tunneled is obtained in writing. Where sewers have to be constructed along narrow passages, Architect/Consultants may permit the excavation to be made partly in tunnel and in such cases the excavated soil shall be brought back later on for refilling the trenches or tunnel.

7.5 OPENING OUT TRENCHES

In Excavating the trenches, etc. the solid road metalling, pavement, curbing, etc. and turf is to be placed on one side and preserved for reinstatement when the trenches or other excavation shall be filled up. Before any road metal is replaced, it shall be shifted the surface of all trenches and holes shall be restored and maintained to the satisfaction of Architect/Consultants and of the owner of the roads or other property traversed and the contractor shall not cut out or Break Down any live fence of trees.
in the line of the proposed works but shall tunnel under them, unless Architect/Consultants shall order to the contrary.

The contractor shall grub up the clear the surface over the trenches and other excavations of all trees, stump roots and all other encumbrances affecting executing of the work and shall remove them from the site to the approval of Architect/Consultants.

7.6 REMOVAL OF FILTH

All night soil, filth or any other offensive matter met with during the execution of the works, immediately after it is taken out of any trench, sewer or cesspool, shall not be deposited on to the surface of any street or where it is likely to be a nuisance or passed into any sewer or drain but shall be at once put into the carts and removed to a suitable place to be provided by the contractor.

7.7 EXCAVATION TO BE TAKEN TO PROPER DEPTHS

The Trenches shall be excavated to such a depth that the sewer shall rest on concrete as described in the several clauses relating there to and so that the inverts may be at the levels given in the sections. In bad ground, the Architect/Consultants may order the contractor to excavate to a greater depth than that shown on the drawings and to fill up the excavation to the level of the sewers with concrete, broken stone, gravel or other materials. For such extra excavation and concrete, Broken Stone, Gravel or other materials, the contractor shall be paid extra at rates laid down for such works in the schedule. If the extra work was operated by the Architect/Consultants in writing, but if the contractor should excavate the trench to a greater depth than is required without a specific order to that effect in writing of the Architect/Consultants the extra depth shall have to be filled up with concrete at the contractor's own costs and charges to the requirements and satisfactions of the Architect/Consultants.

7.8 REFILLING

After the Sewer or other work has been laid and proved to be water tight, the trench or other excavations shall be refilled. Utmost care shall be taken in doing this, so that no damage shall be caused to the sewer and other permanent work. The filling in the haunches and up to 75cms above the crown of the sewer shall consist of the finest selected materials placed carefully in 15cms layers and flooded and consolidated. After this has been laid, the trench and other excavation shall be refilled carefully in 15cms layers with materials taken from the excavation. Each layer being watered to assist in the consolidation unless the Architect/Consultants shall instruct otherwise.

7.9 CONTRACTOR TO RESTORE SETTLEMENT AND DAMAGES

The Contractor shall, at his own costs and charges, take good promptly during the whole period the works surfaces of roads, beams, footpaths, gardens, open spaces etc. Whether public or private caused by his trenches or by his other excavations and he shall be liable for any accidents caused thereby. He shall also, at his own expense and charges, repair and make good any damage done to buildings and other property. If in the opinion of the Architect/Consultants, he fails to make good such works with all practicable dispatch. The Architect/Consultants shall be at Liberty to get the work done by other means and the expense thereof shall be paid by the contractor or deducted from any money that may be or become due to him or recovered from him in any other manner according to the law of the land.
7.10 **DISPOSAL OF SURPLUS SOIL**

The contractor shall at his own costs and charges provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled the surplus soil shall be immediately removed, the surface properly restored and roadways and sides left clear.

7.11 **TIMBERING OF SEWER AND TRENCHES**

a) The contractor shall at all times support efficiently and effectively the sides of the sewer trenches and other excavations by suitable timbering, piling and sheeting and they shall be closed. Timbered in loose or sandy strata and below the surface timbering, piling and sheeting and they shall be closed.

b) All Timbering, sheeting and piling with their walling and supports shall be of adequate dimensions and strength and fully braced and strutted so that no risk of collapse or subsidence of the walls of the trench shall take plan.

c) The contractor shall be held responsible and will be accountable for the sufficiency of all timbering, bracing, sheeting and piling used as also for all damage to persons and property resulting from improper quality, strength, placing, maintaining or removing of the same.

7.12 **REMOVAL OF WATER FROM SEWER, TRENCH ETC.**

a) The contractor shall at all times during the progress of the work keep the trenches and excavations free from water which shall be disposed of by him in a manner as will neither cause injury to the public health nor to the public or private property nor to the work completed or in progress nor to the surface of any roads of streets, nor cause any interference with the use of the same by the public.

b) If any excavation is carried out at any point or points to a greater width than the specified cross section of the sewer with its envelope, the full width of the trench shall be filled with concrete by the contractor at his own expenses and charges to the requirements of the Architect/Consultants.

7.13 **WIDTH OF TRENCH**

The Architect/Consultants shall have power by giving by order in writing to the contractor to increase the maximum width in respect of which payment will be allowed for excavation in trenches for various classes of sewer, manholes, and other works in certain lengths to be specifically laid down by him, where on account of bad ground or other unusual conditions, he considers that such increased widths are necessary in view of the site conditions.

Recommended width of trenches at the button of the trench are as follows:-

<table>
<thead>
<tr>
<th>Pipe Diameter</th>
<th>Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 mm dia Pipe</td>
<td>55 cms</td>
</tr>
<tr>
<td>150 mm dia Pipe</td>
<td>55 cms</td>
</tr>
<tr>
<td>225-250 mm dia Pipe</td>
<td>60 cms</td>
</tr>
<tr>
<td>300 mm dia Pipe</td>
<td>75 cms</td>
</tr>
</tbody>
</table>

Maximum width of the bed concrete shall also be as above. No additional payment is admissible for widths greater than specified.
7.14 SALT GLAZED STONEWARE PIPES

Stoneware pipes shall be of first-class quality salt glazed and free from rough texture inside and outside and straight. All pipes shall have the manufacturer’s name marked on it and shall comply to I.S. 651 of makes approved by the Architect/Consultants

7.15 LAYING AND JOINTING OF SALT GLAZED STONEWARE PIPES

a) Pipes are liable to be damaged in transit and notwithstanding tests that may have been made before dispatch each pipe shall be examined carefully on arrival at site. Each pipe shall be rung with a wooden hammer or mallet and those that do not ring true and clear shall be rejected. Sound pipes shall be carefully stacked to prevent damage. All defective pipes should be segregated, marked in a conspicuous manner and their use in the works prevented.

b) The pipes shall be laid with sockets leading uphill and should rest on solid and even foundations for the full length of the barrel. Socket holes shall be formed in the foundation sufficiently deep to allow the pipe jointer room to work right round the pipe and as short as practicable to admit the socket and allow the joint to be made.

c) Where pipes are not bedded on concrete the trench bottom shall be left slightly high and carefully bottomed up as pipe laying proceeds so that the pipe barrels rest on firm bound. If excavation has been carried too low it shall be made up with cement concrete at the contractor’s cost and charges.

d) If the bottom of the trench consists of Rock or very hard ground that cannot be easily excavated to a smooth surface, the pipes shall be laid on cement concrete bed to ensure even bearing.

Jointing of Pipes

a) Tarred gaskin shall first be wrapped round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid, the pipe shall then be adjusted and fixed in its correct position and the gaskin caulked tightly home so as to fill not more than one quarter of the total length of the socket.

b) The remainder of the socket shall be filled with stiff mix of cement mortar (1 cement : 1 clear sharp washed sand). When the socket is filled, a fillet should be formed round the joint with a trowel forming an angle of 45 degrees with the barrel of the pipe the mortar shall be mixed for immediate use and no mortar shall be used after it has begun to set.

d) After the joint has been made any extraneous materials shall be removed from inside of the joint with a suitable scraper of “Badger”. The newly made joints shall be protected until set from the sun, drying winds, rain or dust. Sacking or other materials which can be kept damp shall be used. The joints shall be exposed and space left all-round the pipes for inspection by the Architect/Consultants. The inside of the sewer must be left absolutely clear in bore and free from cement mortar or other obstructions throughout its entire length, and shall efficiently drain and discharge.

Testing

a) All lengths of the sewer and drain shall be fully tested for water tightness by means of water pressure maintained for not less than 30 minutes. Testing shall be carried out from manhole to manhole. All pipes shall be subjected to a test pressure of at least 1.5 meter head of water. The test pressure shall, however, not exceed a meter head at any point. The pipes shall be
plugged preferably with standard design plugs with rubber plugs on both ends. The upper end shall, however, be connected to a pipe for filling with water and getting the required head.

b) Sewer Lines shall be tested for straightness by:

i) Inserting a smooth ball 12mm less than the internal diameter of the pipe. In the absence of obstructions such as yarn or mortar projecting at the joints the ball should roll down the invert of the pipe and emerge at the lower end.

ii) Means of a mirror at one and a lamp at the other end. If the pipe line is straight the full circle of light will be seen otherwise obstruction of deviation will be apparent.

c) The contractor shall give a smoke test to the drains and sewer at his own expense and charges, if directed by the Architect/Consultants.

d) A test register shall be maintained which shall be signed and dated by contractor, and representative of Architect/Consultants.

7.16 GULLY TRAPS

The gully traps shall be of the first quality and free from rough texture.

Gully traps shall be fixed in cement concrete 1:5:10 mix and a brick masonry chamber 30x30cms inside in cement mortar 1:5 with 15x15cms grating inside and 30x30cms C.I. sealed cover and frame weighing not less than 7.3kg to be constructed as per standard drawing. Where necessary, sealed cover shall be replaced with C.I. grating of the same size (1 cement :5 coarse sand :10 stone aggregate 40mm nominal size).

7.17 REINFORCED CEMENT CONCRETE PIPES

All underground storm water drainage pipes and sewer lines where specified (other than those specified cast iron shall be centrifugally spun RCC pipes of specified class. Pipes shall be straight with uniform bore, throughout. Cracked, warped pipes shall not be used on the work. All pipes shall be tested by the manufacturer and the contractor shall produce, when directed a certificate is that effect from the manufacturer.

Laying

R.C.C. Spun Pipes shall be laid on cement concrete bed or cradles as specified and shown on the detailed drawings. The cradles may be pre-cast and sufficiently cured to prevent cracks and breakage in handling. The invert of the cradles shall be left 12mm below the invert level of the pipe properly placed on the soil to prevent any disturbance. The pipe shall then be placed on the bed concrete or cradles and set for the line and gradient by means of sight rails and boning rods etc. cradles or concrete bed by be omitted, if directed by the Architects/Consultants.

Jointing

After setting out the pipes the collar shall be centered over the joint and filled in with tarred gaskin, so that sufficient space is left on either side of the collar to receive the mortar. The space shall then be filled with cement mortar 1:2 (1cement: 2fine sand) and caulked by means of proper tools. All joints shall be finished at an angle of 45 degrees to the longitudinal axis of the pipe on both sides of the collars neatly.
Testing

All pipes shall be tested to a hydraulic test of 1.5M head for at least 30 minutes at the highest point in the section under test. Test shall also be carried out similar to those for stoneware pipes given above. The smoke test shall be carried out by the contractor, if directed by the Architect/Consultants, at the expense and charges of the contractor. A test register shall be maintained which shall be signed and dated by contractor, and representative of Architect/Consultants.

7.18 CAST IRON PIPES FOR DRAINAGE

All drainage lines passing under Building, floors and roads with heavy traffic, in exposed position above ground E.G. service floor and basement ceiling shall be cast iron pipes. Position of such pipes shall generally be shown on the drawings.

Cast Iron pipes shall be centrifugally spun iron pipes conforming to I.S. 1536-1967. Quality certificates shall be furnished.

Fittings and Inspection Chambers

a) Fittings used for C.I. Drainage pipe shall conform to I.S :1538-1967. Wherever possible junction from branch pipes shall be made by a Y Tee.

b) Contractor shall provide as indicated on drawings or directed by Architect/Consultants cast Iron inspection chamber at all Junction. Inspection chambers shall be specially cast with inlet, outlet and branches of appropriate and required sizes. Branches shall be Y type wherever possible.

c) Cleanout plugs shall be provided on head of each drain and at location indicated on plans or directed by Architect/Consultants. Cleanout plugs shall be of size matching the full bore of the pipe. Plugs shall be made out with G.I coupling caulked into the socket of the pipe or fittings. The end shall be provided with a brass screwed plug with suitable key for opening.

Laying

a) All Cast Iron Pipes and fittings shall be jointed with best quality soft pig lead which shall be free from impurities. In wet trenches joints shall be made from lead wool. Nothing extra will be paid for lead wool joints. Depth of pig lead and weight for joints shall be as given in the sub section “B” of Section II.

b) The Spigot of pipe or fittings shall be centered in the adjoining socket by caulking. Sufficient turns of tarred gaskin will be given to leave unfilled the required depth of socket for depth of 45mm when the gaskin has been caulked tightly home. Joining ring shall be placed round the barrel and against the face of the socket. Molten pig lead shall then be poured to fill the remainder of the socket. This shall then be done in one pouring. The lead shall then be solidly caulked with suitable tools and hammers weighing not less than 2 kg.

c) For lead wool joints the socket shall be caulked with tarred gaskin. As explained above. The lead wool shall be inserted into the sockets and tightly caulked home skein by skein with suitable tools and hammers of not less than 2 kg. Weight until joint is filled.

Alternatively, cast iron pipes and fittings shall also be jointed with drip seal joints as per manufacturer’s specifications where called for.
Testing

All Cast Iron Pipes for drainage shall be tested to a hydraulic test of 3 meter head. Test for straightens shall be same as for stoneware pipe given above. A test register shall be maintained which shall be signed and dated by contractor, and representative of Architect/Consultants.

7.19 CEMENT CONCRETE AND MASONRY WORKS (FOR MANHOLES AND CHAMBERS ETC.)

Materials

a) **Water**

Water used for all the construction purposes shall be clear and free from oil, acid, alkali, organic and other harmful matters, which shall deteriorate the strength and/or durability of the structure. In general, the water suitable for drinking purposes shall be considered good enough for construction purpose.

b) **Aggregate for concrete**

The aggregate for concrete shall be in accordance with I.S. 383 and I.S. 515. In general, these shall be free from all impurities that may cause corrosion of the reinforcement. Before actual use these shall be washed in water, if required as per the direction of Architect/Consultants. The size of the coarse aggregate shall be done as per I.S. 383.

c) **Sand**

Sand for various construction purposes shall comply in all respects with I.S. 650 and I.S. 2116. It shall be clean, coarse hard and strong, sharp, durable, uncoated, free from any mixture of clay, dust, vegetable matters, mica, iron impurities soft or flaky and elongated particles, alkali, organic matters, salt, loam and other impurities which may be considered by the Architect/Consultants as harmful for the construction.

d) **Cement**

The cement used for all the constructional purposes shall be ordinary portland cement or rapid hardening portland cement conforming to I.S. 269.

e) **Mild Steel reinforcement**

The Mild Steel for the reinforcement bars shall be in the form of round bars confirming to all requirements of I.S. 432 Grade I.

f) **Bricks**

Bricks shall have uniform color, thoroughly burnt but not over burnt, shall have plain rectangular faces with parallel sides and sharp right angled edges. They should give ringing sound when struck. Brick shall not absorb more than 20% to 22% of water, when immersed in water for 24 hours. Bricks to be used shall be approved by the Architect/Consultants.

g) **Others Materials**
Other materials not fully specified in these specifications and which may be required in the work shall conform to the latest I.S. All such materials shall be approved by the Architect/Consultants.

**Cement concrete** (Plain or Reinforced)

- **a)** Cement concrete pipes bedding, cradles, foundations and R.C.C. Slabs for all works shall be mixed by a mechanical mixer where quantities of the concrete poured at one time permit. Hand mixing on properly constructed platforms may be allowed for small quantities by the Architect/Consultants. Rate for cement concrete shall be inclusive of all shuttering and centering at all depth and heights.

- **b)** Concrete work shall be of such thickness and mix as given in the schedule of quantities.

- **c)** All concrete work shall be cured for a period of at least 7 days. Such work shall be kept moist by means of gunny bags at all times. All pipes trenches and foundations shall be kept dry during the curing period.

7.20 **MASONRY WORK**

Masonry work for manholes, chambers, and such other works as required shall be constructed from 1st class bricks as specified in the schedule of quantities in cement mortar 1:5 mix (1 cement: 5 coarse sand). All joints shall be properly raked to receive plaster.

**Cement Concrete** for pipe Support

- **a)** Wherever specified or shown on the drawings, all pipes shall be supported in bed all round or in haunches. The thickness and mix of the concrete shall be given in the schedule of quantities. Width of the bedding shall be as per para 4.14.

- **b)** Unless otherwise directed by the Architect/Consultants cement concrete for bed, all round or in haunches shall be laid as follows:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Up to 1.5m Depth</th>
<th>Up to 3m Depth</th>
<th>Beyond 3m Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCC or S.W pipes in open ground</td>
<td>(1:4:8)</td>
<td>In Haunches</td>
<td>All round</td>
</tr>
<tr>
<td>(No sub soil water)</td>
<td></td>
<td>(1:4:8)</td>
<td>(1:4:8)</td>
</tr>
<tr>
<td>RCC or S.W. in sub soil water</td>
<td>All Round</td>
<td>In Haunches</td>
<td>In Haunches</td>
</tr>
<tr>
<td></td>
<td>(1:3:6)</td>
<td>(1:3:6)</td>
<td>(1:3:6)</td>
</tr>
<tr>
<td>C.I. Pipes (In all conditions)</td>
<td>All Round</td>
<td>In Haunches</td>
<td>In Haunches</td>
</tr>
<tr>
<td></td>
<td>(1:3:6)</td>
<td>(1:3:6)</td>
<td>(1:3:6)</td>
</tr>
<tr>
<td>RCC Pipes or CI Pipes</td>
<td>All round</td>
<td>In Haunches</td>
<td>In Haunches</td>
</tr>
<tr>
<td>All round in Haunches under of Building</td>
<td>(1 cement: 3coars: 6 stone aggregate 40mm nominal size)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **c)** R.C.C Pipe or C.I. Pipes may be supported on brick masonry or pre-cast R.C.C. or in situ cables. Cradles shall be as shown on the drawings.

- **d)** Pipes in loose soil or above ground shall be supported on brick or stone masonry pillars as shown on the drawings.
7.21 MANHOLES AND CHAMBERS

All Manholes, Chambers, and other such works as specified shall be constructed in brick masonry in cement mortar 1:5 (1 cement 5 coarse sand) or as specified in the schedule of quantities.

All manholes, chambers, etc. shall be supported on base of cement concrete of such thickness and mix as given in the schedule of quantities or shown on the drawings.

Where not specified, manholes shall be constructed as follows: -
(All Dimensions Internal clear in cms)

<table>
<thead>
<tr>
<th>Size of Manhole</th>
<th>90x80</th>
<th>45x90</th>
<th>90dia</th>
<th>140dia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rect.</td>
<td></td>
<td>Rect.</td>
<td>Conical</td>
<td>Conical</td>
</tr>
<tr>
<td>Maximum Depth</td>
<td>200</td>
<td>200</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>Average Thickness of R.C.C Slab</td>
<td>15</td>
<td>15</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Size of cover and frame</td>
<td>90x45</td>
<td>50dia</td>
<td>50dia</td>
<td>50dia</td>
</tr>
</tbody>
</table>

All Manholes shall be provided with cement concrete benching in 1:2:4 mix. The benching shall have a slope of 10cms towards the channel. The depth of the channel shall be full diameter of the pipe. Benchings shall be finished with a floating coat of neat cement. (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nom. size)

All Manholes shall be plastered with 12/15 mm thick cement mortar 1:3 (1 cement: 3 coarse sand) and finished with a floating coat of neat cement inside. Manhole shall be plastered outside as above but with rough plaster.

All Manholes with depths greater than 1m. shall be provided with 20mm square or 25mm round rods catch rings set in cement concrete blocks 25x10x10cms in 1:2:4 mix 30cms vertically and staggered. Foot rests shall be coated with coal tar before embedding.

All Manholes shall be provided with cast iron covers and frames and embedded in reinforced cement concrete slab. Weight of cover, frame and thickness of slab shall be as specified in the schedule of quantities or given above.

7.22 DROP CONNECTION

Drop connections shall be provided between branch sewer and main sewer itself in steep ground when the difference in invert level of the two exceeds 45 cms of the required sizes.

Drop connections from gully traps to main sewer on rectangular manholes shall be made inside the manholes and shall have H.C.I. special type door bend on top and heel rest bend at bottom connected by a H.C.I. pipe. This pipe shall be supported by holder bat clamps at 180cms intervals with at least one clamp for each drop connection. All joints shall be lead caulked joints 25mm deep.

Drop connections from branch sewer to main sewer shall be made outside the manhole wall with glazed stoneware pipe tee connections, vertical pipe and
bend at the bottoms. The top of the tee shall be finished up to the surface level and provided with a C.I. Hinged type frame and cover 30cms x 30cms. The connection shall be embedded in cement concrete 1:2:4 mix 5cms all-round the pipe and tee up to the surface chamber of the tee.

Drop connection made for vertical stacks directly into manholes shall not be considered as drop connections. They shall be paid for under the relevant soil and waste pipes.

7.23 MAKING CONNECTIONS

Contractor shall connect the new sewer line to the existing manhole by cutting the walls, benching and restoring them to the original condition. A new channel shall be cut in the benching of the existing manhole for the new connection. Contractor shall remove all sewage and water if encountered in making the connection without additional cost.

7.24 ROUTE MARKERS

Markers indicating the particular service installed shall be provided along the routes of pipe trenches. Markers shall be of mild steel indicating the type of service installed and the direction of flow painted on it. The markers shall be set firmly in a concrete base and installed at all corner sand turning points. Over straight runs, markers shall be spaced at 50 meter centers generally.

7.25 MEASUREMENTS

Excavation

Measurement for excavation of pipe trenches shall be made per linear meter under the respective category of soil classification encountered at site.

a) Ordinary soil
b) Hard soil (Hard Moorum & Soft Rock)
c) Hard Rock requiring chiseling
d) Hard Rock required blasting.

Trenches shall be measured between outside walls of manhole at top and depth shall be the average depth between the two ends to the nearest cm. The rate quoted shall be for a depth up to 1.5 m or as given in the schedule of quantities.

Payment for trenches more than 1.5 m in depth shall be made for extra depth as given in the schedule of quantities and above the rate for depth up to 1.5 m.

Timbering and Shoring

Timbering and shoring as described above shall be measured per Sqm and paid for as per the type of timbering of shoring done at site and as per the relevant item in the schedule of quantities. Rate for timbering and shoring shall be for all depths and types of soil classifications including saturated.

Saturated Soil

No extra payment for pumping and bailing out water shall be made for excavation with an average depth of 1.5m in saturated soil, surface water from rain falls or broken pipes lines, or sieves and other similar sources. An extra rate as quoted in the schedule of quantities shall be paid for excavation in
saturated soil for pipe trenches above average depth of 1.5 m. No payment is admissible for water collected from surface sources and broken pipe lines or sewers.

Refilling, Consolidation and Disposal of surplus earth

Rate quoted for excavation of trenches shall be inclusive of refilling, consolidation and disposal of surplus earth within a lead of 50 m.

Stoneware Pipes/R.C.C. Pipes/C.I. Pipes

Stoneware Pipes/R.C.C. Pipes/C.I. Pipes shall be measured for the finished length of the pipe line per linear meter i.e., (A) lengths between manholes shall be recorded from inside of one manhole to inside of other manhole, (B) Length between gully trap and manhole shall be recorded between socket of pipe near gully trap and inside of manhole. Rate shall include all items given in the schedule of quantities and specification.

Gully Trap

Gully traps shall be measured by the number and rate shall include all excavation, foundation, concrete brick masonry, cement plaster inside and outside, C.I. grating and sealed cover and frame.

Cement Concrete for Pipes

Cement concrete in bed and all-round or in Haunches shall be paid per running meter between the outside wall of manholes at bottom of the trench. No additional payment is admissible in respect of concreting done for widths greater than specified, for shuttering or centering and concreting in sub soil water conditions.

Manholes

a) All manholes shall be measured by numbers and shall include all items specified above and necessary excavation, refilling and disposal of surplus earth.

b) Manholes with depth greater than specified under the main item shall be paid for under “Extra Depth” and shall include all items as given for manholes. Measurement shall be done to the nearest cm. depth of the manholes shall be measured from top of the manhole cover to bottom of channel.

Drop Connections

Drop connections shall be measured by number for a depth of 60cms or part thereof between invert levels. Additional depth shall be paid for as extra per meter depth as per the actual length of the drop connection, measured to the nearest cm.

Making Connections

Item for making connection to municipal sewer shall be paid for by number and shall include all items given in the schedule of quantities and specifications.

Masonry Drains

Payment for masonry drains shall be made under individual items of masonry, cement concrete and plaster by volume or area as given in the schedule of quantities. Except for such drawings which are specifically provided in schedule of quantities.

9. SOIL, WASTE & RAINWATER SYSTEM
GENERAL

Water supply system to cater for drinking, washing, flushing & other requirements shall be installed as called for on the drawings.

The piping system consists of PVC SWR System, UPVC Pipes or other material as called for. The size and makes are specified in the Schedule of Quantities.

9.1 SCOPE OF WORK

Work under the section shall consist of furnishing all labor, materials, equipments and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes as required by the drawings, specified hereinafter and given in the schedule of quantitites.

Without restricting to the generality of the foregoing the soil, waste, vent, and rainwater pipes system shall include the following: -

a) Vertical and Horizontal soil, waste and vent pipes, rainwater pipes and fittings, joints, clamps and connections to fixtures.

b) Connection of all pipes to sewer and storm water lines as show on the drawings.

c) Waste pipe connections from all fixtures W.C. Wash Basin, Sinks, Urinals, Kitchen equipment and Plant room equipment.

9.2 TRAPS

External Traps

All traps for drains shall be socket-less tar free cast iron with water seal. Traps shall be provided with an expansion plug and a with a water tight plate at the base for traps located above ground.

Nahani Trap or Floor Traps.

Nahani traps or floor traps shall be cast iron/PVC, deep seal with an effective seal of 50mm. The trap and waste pipes shall be set in cement concrete blocks firmly supported on the structural floor. The blocks shall be in 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20mm nominal size) and extended to 40mm below finished floor level. Contractor shall provide all necessary shuttering and centering for the blocks. Size of the block shall be 30x30cms. of the required depth.

9.3 FLOOR DRAINS AND ROOF DRAINS

A. All floor drain shall have 80mm trap.

B. Floor drains for mechanical room shall have cast iron grating and body. These floor drains shall be heavy duty.

C. Roof Drains shall have cast iron body, flushing clamp and gravel stop with cast iron dome (JR Smith or equivalent).

9.4 FLOOR TRAP INLET

Bath room traps and connection shall ensure free a silent flow of discharging water. Where specified, contractor shall provide a special type fabricated GI pipe inlet Hopper without or with one, two or three inlet sockets to receive the waste pipes. Joint between waste hopper inlet socket shall be lead.
9.5 C.P./STAINLESS STEEL GRATINGS

Floor and Urinal traps shall be provided with square or round C.P./ Stainless steel grating, with rim of approved design and sharp. Minimum thickness shall be 4 to 5 mm or as specified in the schedule of quantities.

9.6 JOINTING

Cast Iron Soil, Waste vent and rainwater pipes shall be jointed with refined Pig lead confirming to IS: 89-1977 sufficient skein of jute row shall be caulked to live a minimum space for the pig lead as given in 3.1.2 to be poured in. After the pouring the lead shall be caulked into the joint with caulking tool and hammer. All surplus lead should be cut and joint left flush with the edge of socket neatly. Alternative to lead joint, cast iron pipes may also jointed with Drip Seal Joint as per manufacturer recommendations. All PVC SWR systems for drainage shall be jointed with rubber lubricant ring joints.

9.7 CLEANOUTS

A. Provide cleanouts at the base of all soil, waste and leader stacks, all changes in direction of horizontal piping, every floor of sanitary, vent and rain water stacks, all branch connections to stacks and every 15m of horizontal pipe runs. Cleanout plugs shall be threaded and provided with key holes for opening. Cleanout plugs shall be fixed to the pipe by a GI socket and lead caulked joint.

B. UPVC Pipe Cleanouts. Heavy plastic cleanout screw plug in UPVC fitting with sound square nut.

C. Extend cleanouts to walls and floor with long sweep ells or “wye” and 1/8 bends with plugs and face or deck plates to conform to the architectural finish in the room. Where no definite finish is indicated on drawings provided by other Divisions of this Specification, use stainless steel wall plates and floor plates of nickel bronze.

9.8 WASTE PIPE FROM APPLIANCES

Waste Pipe from appliances e.g. washbasins, sinks, urinals, water coolers, shall be of upvc or galvanized steel, as given in the schedule of quantities.

All pipes shall be fixed in gradient towards the out falls of drains. Pipes shall be in chase unless otherwise shown on drawings.

9.10 INSTALLATION

A. General

2. All materials shall be new and installed in a first class manner.

3. All drainage piping, unless otherwise indicated, shall be pitched at a minimum rate in direction of flow, in accordance with Indian Standard.

4. Branch connections to stacks or main drain shall not be made in a manner which will permit backflow.
5. The Contractor shall handle fittings into and out of store to job site and they shall be well protected from damage. After the installation, the fixtures shall be covered by protective crating with carton cardboard and plastic sheets until handover to the employer.

6. The Contractor shall supply all jointing and fixing materials and seal to structure with polysulphide sealant and make all connections to water supply services, overflows and waste.

7. All pipe work and fitting connected to pit shall be cast in prior the pouring of concrete.

8. Rainwater drain shall be set in position and make good. The Contractor shall ensure that the works are coordinated.

B. Testing

1. All testing to be carried out in accordance with the local authority requirements and Indian Standards.

2. During the progress of the work, test the waste and storm drainage systems to permit general construction and building in of rough work to proceed.

3. Provide all apparatus and temporary work for tests. Take all due precautions to prevent damage to any part of the building.

4. No caulking of pipe joints to remedy leaks will be permitted except where lead and oakum joints are used.

5. Each sections of drainage and roughing piping tested shall have all openings tightly closed with screw plugs, or equal device, and shall stand without loss of level for a period of four hours when filled with water to produce at least a 3meter head at the highest point of the section tested.

6. The Contractor shall maintain system until handover and ensure that at handover the systems are clean and free of blockage.

7. Test Procedure

   Before use at site, all CI soil pipes shall be tested by filling up with water for at least 10 minutes. After filling, pipes shall be struck with a hammer and inspected for blow holes and cracks. All defective pipes shall be rejected and removed from the site.

   Pipes shall be tested after installation, by filling up the stack with water. All openings in connection shall be suitably plugged. The total head in the stack shall be, however, not exceed 3 m.

   Alternatively, contractor may test all soil and waste stacks by smoke testing machine. Smoke shall be pumped into the stack after plugging all inlets and connections. The stack then be observed for leakages and all defective pipes and fittings removed or repaired as directed by the owner/consultant.

   A test register shall be maintained and all entries shall be signed and dated by contractors and got approved from owner/consultant.

9.11 CEMENT CONCRETE
Cast Iron soil and Waste pipes under floor in sunken slabs and in wall chases (vane cut specially for the pipe) shall be encased in cement, concrete in 1:2:4 mix. The encased pipe shall be supported with suitable cement, concrete, pillars of required height and size at intervals as directed by owner/consultant.

9.12 PAINTING

Soil, waste vent and rainwater pipes in exposed location, in shafts and pipe spaced shall be painted with two or more coats of synthetic enamel paint to give an ever shade.

Paint shall be of approved quality and shade, where directed pipe shall be painted in accordance with approved pipe color code.

Waste pipe in chase shall be painted with two coats of bitumen paint covered with polythene tape/fiberglass tissue wrapping and final coat of bitumen paint. Exposed pipes shall be painted with two or more coats of synthetic enamel paint.

<table>
<thead>
<tr>
<th>Pipe content</th>
<th>Basic colour (150mm)</th>
<th>Colour code indication (100mm)</th>
<th>Basic colour (150mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drinking</td>
<td>Green</td>
<td>Blue</td>
<td>Green</td>
</tr>
<tr>
<td>Grey Water</td>
<td>Green</td>
<td>Black</td>
<td>Green</td>
</tr>
<tr>
<td>Reclaimed Water</td>
<td>Green</td>
<td>Black – White – Black</td>
<td>Green</td>
</tr>
<tr>
<td><strong>Cooling (primary)</strong></td>
<td>Green</td>
<td>White</td>
<td>Green</td>
</tr>
<tr>
<td>Boiler feed</td>
<td>Green</td>
<td>Crimson – White – Crimson</td>
<td>Green</td>
</tr>
<tr>
<td>Condensate</td>
<td>Green</td>
<td>Crimson – Em. Green – Crimson</td>
<td>Green</td>
</tr>
<tr>
<td>Chilled</td>
<td>Green</td>
<td>White – Em. Green – White</td>
<td>Green</td>
</tr>
<tr>
<td>Heating &lt; 100°C</td>
<td>Green</td>
<td>Blue – Crimson – Blue</td>
<td>Green</td>
</tr>
<tr>
<td>Heating &gt; 100°C</td>
<td>Green</td>
<td>Crimson – Blue – Crimson</td>
<td>Green</td>
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<tr>
<td>Cold distribution</td>
<td>Green</td>
<td>White – Blue – White</td>
<td>Green</td>
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<tr>
<td>Hot distribution</td>
<td>Green</td>
<td>White – Crimson – White</td>
<td>Green</td>
</tr>
<tr>
<td>Fire distribution</td>
<td>Green</td>
<td>Safety Red</td>
<td>Green</td>
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<tr>
<td>Sea, river-untreated</td>
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<td>Green</td>
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</tr>
<tr>
<td><strong>Gas</strong></td>
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<td></td>
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</tr>
<tr>
<td>Natural</td>
<td>Yellow Ochre</td>
<td>Yellow</td>
<td>Yellow Ochre</td>
</tr>
<tr>
<td>Manufactured</td>
<td>Yellow Ochre</td>
<td>Em. Green</td>
<td>Yellow Ochre</td>
</tr>
<tr>
<td><strong>Oil</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diesel fuel</td>
<td>Brown</td>
<td>White</td>
<td>Brown</td>
</tr>
<tr>
<td>Compressed air</td>
<td></td>
<td>Light Blue</td>
<td></td>
</tr>
<tr>
<td>Vacuum</td>
<td>Light Blue</td>
<td>White</td>
<td>Light Blue</td>
</tr>
<tr>
<td>Steam</td>
<td></td>
<td>Silver Grey</td>
<td></td>
</tr>
</tbody>
</table>

9.13 CUTTING AND MAKING GOOD

Pipes shall be fixed and tested as work proceeds. Contractor shall provide on necessary holed out, cuts and chase in structure member as required. Wherever, holes are cut or left originally, they shall be made good with cement concrete 1:2:4 (1 cement :2 coarse sand :4 stone aggregate 20 mm nominal size) or cement mortar 1:2 (1 cement :2 coarse sand) and the surface restored as in original condition.

9.14 MEASUREMENT

General

Rates for all items quoted shall be inclusive of all work and items given in the above mentioned specification and schedule of quantities and applicable for the work under floor, in shafts or at ceiling level at all heights and depths.
All rates are inclusive of cutting holes and chases in RCC and masonry work and making good the same.

All rates are inclusive of pre-testing and on site testing of the installations, materials and commissioning.

Pipes (Unit of Measurement). Linear meter to the nearest centimeters.

CI (L.A.) pipes shall be measured net when fixed correct to a centimeter including all fittings along its length.

CI soil, waste vent and rain water pipes shall be measured overall along the centre line correct to a centimeter including all fittings along its length. The rate for these pipes shall be inclusive of all fittings, holder bat clamps, lead caulked joints painting and all other items described in the schedule of quantities. Traps structural clamps and cement concrete shall, however, be paid separately under the relevant item.

GI pipes shall be measured per running meter correct to a centimeter for the finished work, which shall includes fittings e.g. bends, tees, elbows, reducers, crosses, sockets, nipples, nuts and painting. The length shall be taken along the centre line of pipes and fittings. All pipes and fittings shall be classified according to their diameter, method of jointing and fixing substance, quality and finish diameter shall be nominal diameter of internal bore. Pipe shall be described as including all cutting and waste. Incase of fitting of an equal bore, the large bore shall be measured.

Cement concrete around pipe shall be measure per along centre of the pipe line measured per linear meter.

Slotted angels/channels shall be measure per linear meter of finished length and shall include support bolts and nuts embedded in machinery which cement concrete blocks nothing extra will be paid for making good the same.

**Painting**

Painting of pipes shall be measured in meter along the centre line of pipes installed. The rate shall include the painting of clamps, suspenders and supports.

**Structural Clamps**

Structural Clamps and U clamps shall be paid for by weight per Kg. Rate shall be inclusive of all anchor fasteners, nuts, bolts, drilling, cutting, welding and painting. Weight of clamps shall be calculated from the actual length used in structural member multiplied by its theoretical weight given in manufactures catalogue. Weight of nuts, bolts shall not be taken into account.

**Excavation for soil pipes.**

No extra payment shall be admissible with respect to excavation refilling and disposal of surplus earth for cast iron and caste pipes.

**9.15 Grease Trap**

As the name suggests; grease trap separates grease waste-water, before being discharged. Grease Traps should be easy to clean and the covers should be fitted with stainless steel (SS) bolts. The grease traps should include a SS tray which collects the grease.

Grease Traps should be air-tight with zero chances of leakage or foul odor suitable to install as required.

Should be made of C I Casting IS: 210 FG: 220 grade & SS-316 as specified in BOQ & final design.

The standard design parameters should be as under.
### PRODUCT SHEET – PS/PPSF01

<table>
<thead>
<tr>
<th>Flow rate - ltr/min</th>
<th>Inlet / Outlet</th>
<th>Holding capacity - ltrs</th>
<th>Bottomcentre to Bottomcentre of inlet</th>
<th>Width</th>
<th>Length</th>
<th>Height</th>
<th>Grease capacity - kgs</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>50mm</td>
<td>15.9</td>
<td>187.5</td>
<td>187.5</td>
<td>262.5</td>
<td>355</td>
<td>280</td>
</tr>
<tr>
<td>28</td>
<td>50mm</td>
<td>25.5</td>
<td>203.125</td>
<td>203.125</td>
<td>337.5</td>
<td>404.5</td>
<td>303.125</td>
</tr>
<tr>
<td>38</td>
<td>60mm</td>
<td>34.3</td>
<td>203.125</td>
<td>203.125</td>
<td>362.5</td>
<td>503.125</td>
<td>303.125</td>
</tr>
<tr>
<td>57</td>
<td>75mm</td>
<td>47.5</td>
<td>259.375</td>
<td>259.375</td>
<td>400</td>
<td>512.5</td>
<td>343.75</td>
</tr>
<tr>
<td>75.5</td>
<td>87.5mm</td>
<td>57.5</td>
<td>287.5</td>
<td>287.5</td>
<td>400</td>
<td>562.5</td>
<td>375</td>
</tr>
<tr>
<td>95</td>
<td>87.5mm</td>
<td>72</td>
<td>300</td>
<td>300</td>
<td>437.5</td>
<td>612.5</td>
<td>412.5</td>
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<tr>
<td>132</td>
<td>87.5mm</td>
<td>104</td>
<td>353</td>
<td>353</td>
<td>450</td>
<td>712.5</td>
<td>481.25</td>
</tr>
<tr>
<td>189</td>
<td>112mm</td>
<td>156</td>
<td>406.25</td>
<td>406.25</td>
<td>556.25</td>
<td>762.5</td>
<td>537.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grease Trap - Cast Iron (IS:210 FG:220 Grade)</th>
<th>Length</th>
<th>Width</th>
<th>Height</th>
<th>Flow rate</th>
<th>Grease capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>4” inlet outlet</td>
<td>1305mm</td>
<td>61.5mm</td>
<td>490mm</td>
<td>100 ltrs/min</td>
<td>25 kgs</td>
</tr>
<tr>
<td>6” inlet outlet</td>
<td>1305mm</td>
<td>61.5mm</td>
<td>490mm</td>
<td>145 ltrs/min</td>
<td>42 kgs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grease Trap - MS/SS</th>
<th>Length</th>
<th>Width</th>
<th>Height</th>
<th>Flow rate</th>
<th>Grease capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2” inlet outlet</td>
<td>510mm</td>
<td>380mm</td>
<td>445mm</td>
<td>50 ltrs/min</td>
<td>11 kgs</td>
</tr>
<tr>
<td>2.5” inlet outlet</td>
<td>510mm</td>
<td>380mm</td>
<td>445mm</td>
<td>70 ltrs/min</td>
<td>21 kgs</td>
</tr>
</tbody>
</table>

**9.16 Patel Pattern or Collection Pipe/inspection chamber**

Patel Pattern Inspection Chamber Box will be used for draining soil & waste pipes from multiple locations into one single outlet typically installed at service floor.

- Chambers should be air-tight with zero chances of leakage or foul odor. Possibility to hung on ceilings at Service floor or basements
- Should be able to act as hub for numerous pipes (LA class and/or PVC) to converge, for directing flow
- Should be able to customize chamber boxes offering any angles required by design.
- Chamber should have has a cover fitted with 10 stainless steel bolts. Easy to clean if chamber clogs.
- Basic material of construction should be C I.

**10. LIST OF APPROVED MANUFACTURERS FOR PLUMBING**

1. Cast Iron Pipe                        NECO / KAPILANSH
2. PVC SWR System                       Supreme/Prince/Finolax/Kisan/Astral
3. Stoneware Pipes & Gully trap        Perfect/Priya
4. RCC Pipes                            Local
5. G.I. Pipes                           Jindal[Hissar]/Prakash Surya/Tata
6. G.I. fittings                        Unik/Zoloto
7. CPVC Pipes & fittings                Supreme/Finolex/ASTRAL
8. uPVC Pipes & fittings                Supreme/Finolex/ASTRAL
9. PPR Pipes                            Supreme/Vectus/SFMC
10. Gun Metal Globe Valves              Zoloto/Sant/Leader/C&R
11. C.I. Butterfly valves/Sluice valve  C&R/Audco/Leader
12. Brass ball valves                   R8/Zoloto/C&R/ Leader
13. Non Return Valve                    C&R/Audco/Zoloto
14. Strainer                            R8/Zoloto
13. Manhole covers with frames
   Raj Iron Foundry, Agra / K.K. Manhole & gratings Ltd. / NECO
14. Centrifugal Pumps
   Kirloskar / Grundfoss / Adelino
15. HP System/Submersible type sump pumps
   Grundfos / Wilo / Adelino
16. Insulation
   Armaflex
17. Level Indicator/Controller
   Minilec / V.automat / Pumptrol
18. HDPE Water Storage Tanks
   Sintex / Durowell Industries.
19. Water meter
   Crescent / Kaycee / Kapstan / Anand Aashi
20. Pressure Guage
   Hguru / Fibig
21. Grease Trap
   Patel / Aco
22. Air Admittance Valve
   Geberit / Studor
23. STP
   Machman / Thermax / Metcon
24. Filtration plant
   Ion exchange / Metcon

NOTE:
1. For all the Equipments & materials, technical submission must be made even though the make appears in approved make.
2. Bidders can suggest an alternative make however the same must be mentioned at the offer stage only, for evaluation & primary acceptance.

### 11.0 Applicable codes & standards

<table>
<thead>
<tr>
<th>Pipes and Fittings</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS : 458</td>
<td>Specification for precast concrete pipes (with and without reinforcement)</td>
</tr>
<tr>
<td>IS : 651</td>
<td>Salat glazed stone ware pipes and fittings.</td>
</tr>
<tr>
<td>IS : 1239 (Part 2)</td>
<td>Mild Steel tubes, tubulars and other wrought steel fittings : Part 2 Mild Steel tubular and other wrought steel pipe fittings.</td>
</tr>
<tr>
<td>IS : 1536</td>
<td>Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.</td>
</tr>
<tr>
<td>IS : 1537</td>
<td>Vertically cast iron pressure pipes for water, gas and sewage.</td>
</tr>
<tr>
<td>IS : 1538</td>
<td>Cast iron fittings for pressure pipes for water, gas and sewage.</td>
</tr>
<tr>
<td>IS : 1729</td>
<td>Sand Cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.</td>
</tr>
<tr>
<td>IS : 1879</td>
<td>Malleable cast iron pipe fittings.</td>
</tr>
<tr>
<td>IS : 1978</td>
<td>Line pipe</td>
</tr>
<tr>
<td>IS : 1979</td>
<td>High test line pipe.</td>
</tr>
<tr>
<td>IS : 2501</td>
<td>Copper tubes for general engineering purposes</td>
</tr>
<tr>
<td>IS : 2643 (Part 1)</td>
<td>Dimensions for pipe threads for fastening purposes : Part 1 Basic profile and dimensions.</td>
</tr>
<tr>
<td>IS : 2643 (Part 2)</td>
<td>Dimensions for pipe threads for fastening purposes: Part 2 Tolerances.</td>
</tr>
<tr>
<td>IS : 2643 (Part 3)</td>
<td>Dimensions for pipe threads for fastening purposes: Part 3 Limits of sizes.</td>
</tr>
<tr>
<td>IS : 3468</td>
<td>Pipe nuts.</td>
</tr>
<tr>
<td>IS : 3589</td>
<td>Seamless or electrically welded steel pipes for water, gas and sewage (168.3 mm to 2032 mm outside diameter).</td>
</tr>
<tr>
<td>IS : 3989</td>
<td>Centrifugally cast (sun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.</td>
</tr>
<tr>
<td>IS : 4346</td>
<td>Specifications for washers for use with fittings for water services.</td>
</tr>
<tr>
<td>IS : 4711</td>
<td>Methods for sampling steel pipes, tubes and fittings.</td>
</tr>
<tr>
<td>IS : 6392</td>
<td>Steel pipe flanges</td>
</tr>
<tr>
<td>IS : 6418</td>
<td>Cast iron and malleable cast iron flanges for general engineering purposes.</td>
</tr>
<tr>
<td>Specification</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------</td>
</tr>
<tr>
<td>IS : 7181</td>
<td>Specification for horizontally cast iron double flanged pipe for water, gas and sewage.</td>
</tr>
<tr>
<td><strong>Valves</strong></td>
<td></td>
</tr>
<tr>
<td>IS : 778</td>
<td>Specification for copper alloy gage, globe and check valves for water works purposes.</td>
</tr>
<tr>
<td>IS : 780</td>
<td>Specification for sluice valves for water works purposes (50 mm to 300 mm size).</td>
</tr>
<tr>
<td>IS : 1703</td>
<td>Specification copper alloy float valves (horizontal plunger type) for water supply fittings.</td>
</tr>
<tr>
<td>IS : 2906</td>
<td>Specification for sluice valves for water works purposes (350 mm to 1200 mm size)</td>
</tr>
<tr>
<td>IS : 3950</td>
<td>Specification for surface boxes for sluice valves.</td>
</tr>
<tr>
<td>IS : 5312 (Part 1)</td>
<td>Specification for swing check type reflux (non return) valves : part 2 Multi door pattern.</td>
</tr>
<tr>
<td>IS : 5312 (Part 2)</td>
<td>Specification for swing check type reflux (non return) valves : part 2 Multi door pattern.</td>
</tr>
<tr>
<td>IS : 12992 (Part 1)</td>
<td>Safety relief valves, spring loaded : Design</td>
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<tr>
<td>IS : 13095</td>
<td>Butterfly valves for general purposes.</td>
</tr>
<tr>
<td><strong>Water Quality Tolerance</strong></td>
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</tr>
<tr>
<td>IS : 3025 (Parts 1 to 44)</td>
<td>Method of sampling and test (physical and chemical) for water and waste water.</td>
</tr>
<tr>
<td>IS : 4764</td>
<td>Tolerance limits for sewage effluents discharged into inland surface waters.</td>
</tr>
<tr>
<td>IS : 10500</td>
<td>Drinking Water</td>
</tr>
<tr>
<td><strong>Pumps &amp; Vessels</strong></td>
<td></td>
</tr>
<tr>
<td>IS : 1520</td>
<td>Specification for horizontal centrifugal pumps for clear cold fresh water.</td>
</tr>
<tr>
<td>IS : 2002</td>
<td>Steel plates for pressure vessels for intermediate and high temperature service including boilers.</td>
</tr>
<tr>
<td>IS : 2825</td>
<td>Code for unfired pressure vessels.</td>
</tr>
<tr>
<td>IS : 5600</td>
<td>Specification for sewage and drainage pumps</td>
</tr>
<tr>
<td>IS : 8034</td>
<td>Specification for submersible pump sets for clear, cold, fresh water.</td>
</tr>
<tr>
<td>IS : 8418</td>
<td>Specification for horizontal centrifugal self priming pumps.</td>
</tr>
<tr>
<td><strong>Sanitary Fittings</strong></td>
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<tr>
<td>IS : 771 (Part 1 to 3)</td>
<td>Specification for glazed fire clay sanitary appliances.</td>
</tr>
<tr>
<td>IS : 774</td>
<td>Specification for flushing cistern for water closets and urinals (other than plastic cistern)</td>
</tr>
<tr>
<td>IS : 775</td>
<td>Specification for cast iron brackets and supports for wash basins and sinks</td>
</tr>
<tr>
<td>IS : 781</td>
<td>Specification for cast copper alloy screw down bib taps and stop valves for water services.</td>
</tr>
<tr>
<td>IS : 1700</td>
<td>Specification for drinking fountains.</td>
</tr>
<tr>
<td>IS : 2556 (Part 2)</td>
<td>Specification for vitreous sanitary appliances (vitreous china) : Part 2 Specific requirements of wash-down water closets.</td>
</tr>
<tr>
<td>IS : 2556 (Part 3)</td>
<td>Specification for vitreous sanitary appliances (vitreous china) : Part 3 Specific requirements of squatting pans.</td>
</tr>
<tr>
<td>IS : 2556 (Part 4)</td>
<td>Specification for vitreous sanitary appliances (vitreous china) : part 4 specific requirements of wash basins.</td>
</tr>
<tr>
<td>IS : 2556 (Part 6 Sec 2)</td>
<td>Specification for vitreous sanitary appliances (vitreous china) : part 6</td>
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<tr>
<td>Specification</td>
<td>Description</td>
</tr>
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<td>---------------</td>
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<td>IS : 2556 (Part 6 Sec 4)</td>
<td>Specific requirements of urinals, section 2 half stall urinals.</td>
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<td>IS : 2556 (Part 6 Sec 5)</td>
<td>Specification for vitreous sanitary appliances (vitreous china) : Part 6 specific requirements of urinals, section 4 partition slabs.</td>
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<tr>
<td>IS : 2556 (Part 6 Sec 6)</td>
<td>Specification for vitreous sanitary appliances (vitreous china) : Part 6 specific requirements of urinals, section 5 waste fittings.</td>
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<tr>
<td>IS : 2556 (Part 6 Sec 6)</td>
<td>Specification for vitreous sanitary appliances (vitreous china) : Part 6 specific requirements of urinals, section 6 water spreaders for half stall urinals.</td>
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<tr>
<td>IS : 2556 (Part 7)</td>
<td>Specification for vitreous sanitary appliances (vitreous china) : Part 7 specific requirements of half round channels.</td>
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<tr>
<td>IS : 2556 (Part 8)</td>
<td>Specification for vitreous sanitary appliances (vitreous china) : Part 8 specific requirements of siphoning wash down water closets.</td>
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<tr>
<td>IS : 2556 (Part 12)</td>
<td>Specification for vitreous sanitary appliances (vitreous china) : Part 12 specific requirements of floor traps.</td>
</tr>
<tr>
<td>IS : 2692</td>
<td>Specification for ferrule for water services</td>
</tr>
<tr>
<td>IS : 2717</td>
<td>Glossary of terms relating to vitreous enamelware and ceramic metal systems</td>
</tr>
<tr>
<td>IS : 2963</td>
<td>Specifications for waste plug and its accessories for sinks and wash basins.</td>
</tr>
<tr>
<td>IS : 3311</td>
<td>Specification for waste plug and its accessories for sinks and wash basins.</td>
</tr>
<tr>
<td>IS : 5961</td>
<td>Specification for cast iron gratings for drainage purposes.</td>
</tr>
<tr>
<td>IS : 6249</td>
<td>Specification for gel-coated glass fibre reinforced polyester resin bath tubs.</td>
</tr>
<tr>
<td>IS : 6411</td>
<td>Specification for gel-coated glass fibre reinforced polyester resin bath tubes.</td>
</tr>
<tr>
<td>IS : 8931</td>
<td>Specification for copper alloy fancy single taps, combination tap assembly and stop valves for water services.</td>
</tr>
<tr>
<td>IS : 9758</td>
<td>Specification for flush valves and fitting for water closets and urinals.</td>
</tr>
</tbody>
</table>
SPECIFICATION FOR ELECTRICAL WORKS:

SWITCHGEARS & POWER PANELS

SCOPE
- These specifications cover design, manufacture, test and supply of Power Distribution Boards (PDB), Lighting Distribution Board (LDB) and similar fabricated switch boards and panels.

STANDARDS
- All materials, equipment, wires and accessories etc. shall generally conform to relevant Indian Standards. Manufacturer shall bring to the notice of Purchasers in case any of the equipment not conforming to Indian Standards are being used by him.
- Some of the standards are listed below for ready reference.

Fabrication : IS 2147 - Degree of Protection of enclosures.
- IS 3202 - Code of Practice for Climate proofing.
Bus-bars : IS 375 - Marking arrangement of bus bars and wiring.
Components:
- IS 4047 - Heavy Duty air-break switches.
- IS 2208 - HRC fuses
- IS 2959 - AC Contactors
- IS 1822 - AC motor starters
- IS 1248 - Miniature Circuit Breakers

Metering:
- IS 2075 - Current Transformers
- IS 3156 - Voltage Transformers
- IS 1248 - Indicated meters
- IS 722 - AC Electricity Meter

Wiring:
- IS 694 - PVC insulated wires

CLIMATE CONDITIONS
- Switchboards shall generally withstand ambient temperature of 45 deg. C with peak of 50 deg. C for two hours. Humidity will be max. 91%. Boards will be installed in a closed room of 4 meters high and one meter bigger all around the board.
- If atmosphere is conducive to corrosion, special care at gasket ting, hardware and paint shall be taken.

ELECTRICAL SUPPLY SYSTEM
- Supply system is derived from 440 volts, 3 phase, 4 wire secondary of a Distribution transformer.
- Single phase supply shall be derived from one of the three phases and neutral, at 240 volts.

FABRICATION
- Boards shall be fabricated out of 2 mm thick (14 SWG) CRCA sheet steel. Larger sections may be used where required. Unsupported span of sheet steel of main framework and door, shall not exceed 1 meter in any direction. If unavoidable it shall be braced by folded channels for rigidity and strength.
- After fabrication, boards shall be treated for rust removal, welding scales removed, degreased, treated in seven tank process OR by three in one solution, subject to prior approval from Client.
• Free standing boards shall have min. 75 mm high Channel frame. This frame shall be used for grouting/ bolting of boards on floor. Bolt holes on the bottom of the Channel frame shall be accessible by removing gland plate at corresponding locations. Holes shall be 14 diameter for M12 hardware. Main board can be welded/ bolted to this Channel frame.
• For wall mounting boards external fixing lugs, with 14 diameter. Holes for M12 bolts shall be provided. Those shall not project out when seen from front.
• Cable alleys shall have removable gland-plates. Slip holes shall be drilled According to the cable sizes and gland sizes. Extra entries and entries of spare feeders shall be suitably plugged.

PAINTING
• All steel surfaces shall be thoroughly cleaned, welding scales removed, degreased, treated in seven tank process or with three-in-one solution.
• Painting shall be powder coating type with color shade as specified in specific requirements.
• For control panels/ desks, inside surface shall be painted off white.
• For fire protection panels, fire red paint of shade as 538 as per IS 5 shall be used.

CONSTRUCTION
• All the Panels shall be suitable of Form-3b type. Boards shall be of compartmental design, modular construction, unless specified otherwise, every components shall be fully covered from all sides. Equipment mounting plate shall be easily removable along with components and wiring. When removed, live bus-bars shall not be accessible.
• Modules shall be fixed, semi draw-out or fully draw-out as mentioned in specific requirements. In all alternatives isolator shall be interlocked with the door opening, when ELMCB is implied replacing isolator, a flexible shaft operated by stay put type push button on door shall be used to press ‘trip/test’ knob on ELMCB. Isolator incoming terminals shall be fully shrouded to avoid Accidental contact after door is opened. Requirements of semi-draw-out and fully draw-out feeders are described elsewhere.
• Doors shall be adequately hinged on one side. Non deteriorating gaskets shall be provided to make it dust-tight and vermin-proof, door closing knobs shall be key operated cam-type, to compress the gasket sufficiently and ensure dust tightness.
• Gaskets shall also be provided between shipping sections and all joints. Bus-bar compartments shall be fullyshrouded.
• Cable compartments shall have clear opening more than 250 mm, excluding bends of sheets, gaskets etc. knobs of the covers shall have captive washers and guide spool for easy alignment with the fixed nut.
• Boards shall be flush fronted, single front or double front, with specific requirements of back access/dead against wall feature.
• Lifting hooks shall be provided for each shipping section, giving due consideration to centre of gravity of the Cubical. Hooks, if removable, shall leave no opening retaining property of dust tight.

BUS-BARS
• Bus-bars shall be of electrolytic copper or aluminium as specified. Current density shall not exceed 1.2 Amps/ sq.mm, for copper. ( or as specified in specific requirements ) Vendor can use higher current density, if thinner sections of bus-bars are used with proper spacing and configuration.
• Temperature rise in bus-bars shall not exceed 45 deg. Above ambient of 45 deg.C (Please see C.1)
• Bus-bars sleeve is optional. Black mat finish of bus-bars is preferred for better heat dissipation.
• Bus-bars shall withstand short-circuit capacity as mentioned. Number and spacing of supports shall be designed accordingly.
- Tapping of bus-bars shall have contact surface at least four times the cross-section of tapping. Cross section of the risers/tapping shall be rated for 150% of summated capacity of the switches on that section.
- Bimetallic joints shall be avoided as far as possible. If provided, copper surfaces shall be tinned or coated with thin film of corrosion inhibiting compound or provided with bimetal plate.

**COMPONENTS**

**MOULDED CASE CIRCUIT BREAKER**
- The MCCB shall be 4 pole as the need be. In case of 4 pole MCCB, the 4th pole shall be 100% rated. The MCCB shall be available in fixed version. It shall be possible to convert the MCCB from fixed to plug-in/draw-out version. The MCCB shall be manually operated. It shall be possible to convert the MCCB from manually operated to motorized MCCB and vice-versa. Moulded case circuit breakers (MCCB) shall have Thermal magnetic/Microprocessor-based release with overload, short circuit & earth fault protection, as specified. The release shall have communication in future if specified. The MCCB shall be suitable for adapting accessories, such as auxiliary contact block, extended terminal cover & phase barrier etc. MCCBs shall indicate its suitability for isolation and this should appear clearly with the symbol as specified in standard IS 13947/IEC 60947.
- The input and output terminals of the MCCB unit shall be extended and separated so that Aluminium cables of given sizes can be easily terminated in the panel.
- The MCCB shall be provided with front drive mechanism with door interlock with interlock defeating facility.
- The MCCB shall be provided with variable range operating time on short circuit (LSI).
- The MCCB shall be provided with auxiliary contact block.
- The MCCB shall be fully rated for 50 deg.C ambient temperature.

**MINIATURE CIRCUIT BREAKER**
- Miniature circuit breakers shall be quick make and break type for 230/415 VAC, 50Hz application with magnetic thermal release for over current and short circuit protection.
- The breaking capacity shall minimum be 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting be type (Class – 3).
- MCBs shall be classified (B, C, D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer.
- The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP and TPN miniature circuit breakers shall have a common trip bar independent to the external operating handle.

**RESIDUAL CURRENT CIRCUIT BREAKER**
- RCCB shall comply with IS-12640-1996/IEC 61008.
- These shall work on the principle of core balance transformer.
- In a fault-free system, the magnetizing effects of the conductors through which current is flowing cancel each other out for the summation current transformer as, in accordance with Kirchhoff’s current law, the sum of all currents is zero. There is no residual magnetic field left that could induce a voltage in the secondary winding. The unbalanced current shall generates a voltage in the secondary winding, which then uses the release and the breaker mechanism to switch off the electrical circuit.
- RCCB shall be current operated independent of the line voltage; current sensitivity shall be of 30 mA at 240/415 volts.
- The moving contacts of the phases shall be mounted on a common bridge actuated by a rugged toggle mechanism. Hence the closing / opening of all the three phases shall occur simultaneously.
• The neutral moving contact shall be so mounted on the common bridge that at time of closing the neutral shall make contact first before the phases and at the time of opening the neutral shall breaks last after allowing the phases to open first.

• Test button shall be provided to test the residual current protective device. Pressing the test button generates an artificial residual current - the residual current protective device must trip.

• Due to the use of electronic components in household appliances and industrial plants, insulation faults can also cause residual currents that are not AC residual currents to flow through residual current protective devices, even in the case of devices with ground terminals. Hence, Residual current protective devices that trips for both sinusoidal AC residual currents and pulsating DC residual currents (type A) shall be provided.

• Note: All components like MCB, RCCB and RCBO etc. shall be offered with an ISI marking. The manufacturer (through the bidder) has to submit the valid BIS license certificate at the time of offer submission.

  ✓ BIMETAL RELAYS shall be a combination of overload and single phasing preventor. Those shall be hand reset type. For current ratings 100A & above, CT operated relays shall be used. Long starting or saturating CT type BMR shall be used when called for.

  ✓ INDICATING LAMPS shall be rated for low watts, having ballast resistor to drop 30% voltage, and suitable colored lenses spreading glow in all directions. Timers shall be channel mounted electronic/pneumatic with range as specified.

1. METERING & ACCESSORIES

• Current transformers shall be provided with ratio, VA burden and accuracy class as per single line diagram or specific requirements.

• Those shall be epoxy/ resign cast with secondary terminals mounted on the body. Loose hanging secondary leads are not acceptable. If provided, those shall be terminated on a terminal block nearby and wiring neatly dressed.

• Potential Transformers shall be double wound with ratio, VA burden & accuracy class as per SLD or specific requirements. Primary and secondary fuses shall be provided as per rating.

• Control transformers and motor winding heater transformers shall also be double wound having regulation less than 2%. Only primary side fuses are considered adequate.

• Ammeters shall be MISC type, suppressed scale for motor feeders, movement located in one corner for maximum scale length, other details as per specifications. Alternatively, digital type instruments shall be provided, if specifically called for.

• Voltmeters shall be MISC type square pattern, with movement located in one corner. Usual Voltage range shall be broadly expanded. E.g. For 0-500 V voltmeter 350-450 volts range shall be wide spread.

• Wattmeter and power-factor meters shall be three phase, four wire, three element, calibrated for CT ratio and PT ratio as shown in SLD.

• Frequency meter, shall be vibrating rid type or digital type. Pointer type meter shall be provided, when called for. Any additional metering covering KWH meters, DC meters, etc. shall be as shown in SLD.

2. WIRING FERRULES AND TERMINALS

• Wires shall be PVC insulated 660 volts grade with coding as per IS 375.

  POWER WIRES: Color coded R,Y,B, Black; or grey with colored sleeves at both ends, size to suit current rating with current density not more than 2 Amp per sq.mm. Size & type of lugs shall suit equipment termination & shall be of crimping type; finned copper.

  Control Wires:

  Color coding = Grey or black AC 1.5 sq.mm. Multistrand.
= Red wires for DC circuits.
= Different colors for voltages other than above.
= Different colors for voltage when used for.

Two incomers and one bus-coupler, inter-panel wiring shall be red for incomer 1, Yellow for bus coupler, and blue for incomer 2 or prefixed with the breaker designation.

For current transformers secondary, minimum 2.5 sq.mm. Flexible copper wires shall be used.

All wires on doors shall be multi-strand flexible.

Wiring shall be terminated with tinned copper, PVC sleeved crimping lugs, type to suit the terminals of equipment at each end.

- Ferrules shall be yellow, Mel grip type, correctly fitting on outer diameter of wires.
  Ferrules shall read towards end termination. Ferrules '6' and '9' should not be single used. However, may be used single when prefixed by letter e.g. K6, J9.
  Method of ferruling, described in IS 375, shall be followed.
  Equi-potential ferruling method shall be followed.

- Terminals shall be Elmex make, shrouded type, size to suit the wiring. Miniature version of terminals not acceptable. When more than one wire is to be terminated two terminals with fixed type shorting link shall be provided. This is applicable for outgoing cable connections as well. Such linked terminals shall bear same number.
  All outgoing cable terminals shall be Elmex shrouding type CST up to 10 sq.mm. Bolted type connections with crimping lugs shall be provided for 16 sq.mm. And above. In case data regarding outgoing cables is not furnished, vendor shall assume cable size as 1 amp per sq.mm., terminated with crimping type lug of that size. e.g. 250 Amps switch-fuse unit outgoing connection shall be done by 1 No. 240 sq.mm. or 2 nos. 120 sq.mm. cables in parallel.
  No un-shrouded live terminals shall be installed in Cable alley.
  Minimum spacing of 150 mm shall be provided between gland-plate and terminal strip up to 50 terminals in control panel. For terminals more than 50, space shall be increased to 200 mm to accommodate incoming cables. Clearance between two rows of terminals shall not be less than 100mm. This shall be especially applicable to Control desks/ common control panels.
  Barrier Plate shall be provided after every 10 (Ten) terminals to avoid parallax.
  All C.T. Secondary terminals shall have 2 Nos. 4 sq.mm. Terminals, shorted with link, per C.T. to function as C.T. shorting/ test terminals.

- Control terminals, receiving potential from other sources shall be red or painted red. Corresponding wiring shall also be red for fixed type of feeders.

3. MISCELLANEOUS
- Nameplates on all feeders feeder shall be rear engraved Perspex with white letters on black background.
  Two name plates on each feeder shall be provided, one reading feeder number and other reading equipment reference and description for which the feeder is designated. e.g. Feeder Name Plates 4 F3 and equipment reference nameplate ‘P 103-- COOLING WATER PUMP’, shall be independent.
  All similar name plates shall have some fixing screw dimension for interchangeability. Isolator ON-OFF nameplates shall be provided.
  Caution Live terminals stickers in red to be provided at incomers/ other source of supply.
  Also bus-bar chamber covers shall be affixed with such name plates.
Any special caution boards inviting attention of operator shall be white letters on red background. (eg Fire pump feeders, maintenance supply feeders tapped before breaker, auto changeover feeders etc)

- 440 volts caution stickers with skull and bones, shall be affixed on inomers, bus-couplers and side faces of panels.
- All hardware shall be passivated M.S. complete with plain and spring washers. Head shall be hexagonal with screwdriver slot. End of bolt shall be conical to serve as automatic guide and alignment. Captive washers shall also be supplied. Bolts up to M12 shall have screwdriver slot also.
- Accessories to be supplied with board.
  - Grouting bolts.
  - Fuse pullers - 2 nos.
  - Circuit breaker operating handle [S]
  - Touch-up paint (100cc)
  - Blocking plugs for gland entries/ slip-holes.
  - 10% door fixing knobs & gland plate fixing hardware.
  - Lamp grip – 2 Nos.
  - Blanking plates for short supplied meters/ relays.
  - Panel to panel coupling gasket & bolts. Corresponding bus-bar coupling hardware.

4. INGRESS PROTECTION (IP)
- Degree of protection for indoor location-minimum IP 52.
- Degree of protection for Outdoor location-minimum IP 65.
- All doors and openings should be provide with neoprene gaskets to prevent dust entry.
- All cables alley should be provided with space heaters with thermostat to prevent moisture entry and condensation inside the panel

5. EARTHING
- Continuous earth-bus shall be provided all along the panel. Joints at coupling faces shall be lap type with minimum two bolts.
- Size and material shall be designed to withstand ground fault for 1 sec. for given fault level.
- All hinged doors shall be provided with fully welded boss and connected to earth bus by flexible.
- Color coding for earth wires & bus bars shall be green or green with yellow tracing.
- All metal parts shall be ensured for earth continuity.

6. DRAWINGS
- Vendor shall submit 4 prints of general arrangement drawing for review/ comments. Two prints will be returned with comments. Fabrication can proceed thereafter.
- Six prints shall be submitted after fabrication.
- Control wiring diagrams shall be issued to successful bidder. In case vendor wishes to make of his own, above procedure shall be followed.
- For extensible boards, complete drawing showing
  a. Coupling bolts hooks with sizes.
  b. Bus-bar arrangement.
  c. Bolt holes and measurements of end faces.
  d. Location of insulated support from end face, etc. shall be submitted as measured on shop floor during inspection.
7. **INSPECTION**

- Boards shall be inspected by Purchaser or his representative or by both.
- Stage Inspection shall be carried out for boards before painting, with components mounted in the modules/ feeders and one of each type incomers/ bus-coupler.
- Insulators and bus-bars shall be mounted on typical panel and risers. Also bus work at bus-coupler shall be ready for inspection at this stage.
- Boards shall be tested for all electrical tests covering:
  a. Insulation resistance test by 500 volts Insulation Tester (megger).
  b. 2.5 KV power frequency high voltage withstand for one minute.
  c. Insulation resistance test after HV test.
  d. Secondary injection test for relays.
  e. Current injection test and operating time at 2 and 5 times the set value of BMR.
  f. Operation of Earth-leakage relay by 3 watt lamp.
  g. Operational test of feeders by simulating external field conditions.
- Test Certificates in six copies shall be submitted along with the equipment.
AUTOMATIC TRANSFER SWITCH

SCOPE

The scope of work shall cover supply, installation, testing and commissioning of automatic transfer switches (ATS) with number of poles, amperage, voltage, and withstand current ratings as shown on the plans. Each automatic transfer shall consist of an inherently double throw power transfer switch unit and a microprocessor controller, interconnected to provide complete automatic operation.

STANDARDS

The following standards shall be applicable:

- UL 1008 - Standard for Automatic Transfer Switches
- NFPA 70 - National Electrical Code
- NFPA 110 - Emergency and Standby Power Systems
- IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
- NEMA Standard ICS10-1993 (formerly ICS2-447) - AC Automatic Transfer Switches
- NEC Articles 700, 701, 702

ATS

- The transfer switch unit shall be electrically operated and mechanically held. The electrical operator shall be a single-solenoid mechanism, momentarily energized. Main operators which include overcurrent disconnect devices will not be accepted. The switch shall be mechanically interlocked to ensure only one of two possible positions, normal or emergency.
- The switch shall be positively locked and unaffected by momentary outages so that contact pressure is maintained at a constant value and temperature rise at the contacts is minimized for maximum reliability and operating life.
- All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented blow-on construction for high withstand current capability and be protected by separate arcing contacts.
- Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. A manual operating handle shall be provided for maintenance purposes. The handle shall permit the operator to manually stop the contacts at any point throughout their entire travel to inspect and service the contacts when required.
- Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable. Where neutral conductors must be switched, the ATS shall be provided with fully-rated overlapping neutral transfer contacts.
- Where neutral conductors are to be solidly connected, a neutral terminal plate with fully-rated AL-CU pressure connectors shall be provided.

Microprocessor Controller with Membrane Interface Panel

- The controller shall direct the operation of the transfer switch. The controller's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability, minimum maintenance, and inherent serial communications capability. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance.
- The controller shall be enclosed with a protective cover and be mounted separate from the
  transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be
  provided on printed circuit boards. Interfacing relays shall be industrial grade plug-in type with
dust covers.
- The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as
  follows:
  1. ANSI C37.90A/IEEE 472 Voltage Surge Test
  2. NEMA ICS – 109.21 Impulse Withstand Test
  3. IEC801-2 Electrostatic discharge (ESD) immunity
  4. ENV50140 and IEC 801 – 3 Radiated electromagnetic field immunity
  5. IEC 801 – 4 Electrical fast transient (EFT) immunity
  6. ENV50142 Surge transient immunity
  7. ENV50141: Conducted radio-frequency field immunity
  8. EN55011 : Group 1, Class A conducted and radiated emissions
  9. EN61000 – 4 – 11 Voltage dips and interruptions immunity

**Voltage and Frequency Sensing**
- The voltage of each phase of the normal source shall be monitored, with pickup adjustable to 95% of
  nominal and dropout adjustable from 70% to 90% of pickup setting.
- Single-phase voltage and frequency sensing of the emergency source shall be provided.

**Time Delays**
- An adjustable time delay shall be provided to override momentary normal source outages
  and delay all transfer and engine starting signals.
- An adjustable time delay shall be provided on transfer to emergency, adjustable from 0 to 5 minutes
  for controlled timing of transfer of loads to emergency.
- A generator stabilization time delay shall be provided after transfer to emergency.
- An adjustable time delay shall be provided on retransfer to normal, adjustable to 30 minutes. Time
  delays shall be automatically bypassed if emergency source fails and normal source is acceptable.
- A 5-minute cool down time delay shall be provided on shutdown of engine generator.
- All adjustable time delays shall be field adjustable without the use of special tools.

**Additional Features**
- A set of contacts rated 5 amps, 32 VDC shall be provided for a low-voltage engine start signal. The
  start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper
  output, and run for the duration of the cool down setting, regardless of whether the normal
  source restores before the load is transferred.
- A push-button type test switch shall be provided to simulate a normal source failure.
- A push-button type switch to bypass the time delay on transfer to emergency, the engine exerciser
  period on the retransfer to normal time delay whichever delay is active at the time the push-
  button is activated.
- Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to
  emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer
  to normal.
- Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when
  the ATS is connected to the normal source and one contact, closed, when the ATS is connected to the
  emergency source.
- Indicating lights shall be provided, one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red). Also provide indicating lights for both normal and emergency source availability.
- Terminals shall be provided to indicate actual availability of the normal and emergency sources, as determined by the voltage sensing pickup and dropout settings for each source.
- Engine Exerciser - An engine generator exercising timer shall be provided, including a selector switch to select exercise with or without load transfer.
- In phase Monitor - An in phase monitor shall be inherently built into the controls. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents, and shall not require external control of power sources. The in phase monitor shall be specifically designed for and be the product of the ATS manufacturer.
- Selective Load Disconnect - A double throw contact shall be provided to operate after a time delay, adjustable to 20 seconds prior to transfer and reset 0 to 20 seconds after transfer. This contact can be used to selectively disconnect specific load(s) when the transfer switch is transferred. Output contacts shall be rated 6 amps at 28 VDC or 120 VAC.

Optional Accessories

A. Communications Interface - Serial Module (5110) to allow local or remote communications with ASCO Power Quest® or Site Web™ communication products. The module shall be used to connect the Series 300, and ASCO ATS Annunciators to the serial network via an RS-485 interface. The module shall have two port connectors used for ATS & Standalone Power Manager connectivity. (Accessory 72A).

B. Communications Interface – Connectivity Module (5150) to allow several different serial devices that communicate at different baud rates and with different protocols to a common Ethernet media. The module shall be used to connect Series 300 and ASCO ATS Annunciators to the standard Ethernet TCP/IP network with standard 10 base-T [RJ-45] connector. The module shall be designed to communicate with up to 8 clients such as Web applications (web pages) or Power Quest® communication products simultaneously over an Ethernet connection. (Accessory 72E).

C. Programmable Engine Exerciser - A seven or fourteen day programmable engine exerciser with digital readout display. Shall include one form C contact for availability of normal and emergency sources. Include “with or without” load control switch for exerciser period. The exerciser shall be backed up by a permanent battery. (Accessory 11BG).

D. Enclosure Heater - A 125 watt enclosure heater with transformer and thermostat (adjustable from 30° to 140° F) (Accessory 44 G).

E. Power Monitoring and Control

A Power Quest® PC based Automatic Transfer Switch (ATS) remote monitoring and control system designed to communicate with other ATSs located in remote locations shall be provided. System shall

Utilize serial communications capability inherent with the ATS microprocessor based control panel offering. Refer to separate Suggested Specification.

A SiteWeb™ remote monitoring and control system that is accessible from any network connected pc. It shall be an internet browser based system that can be configured to remotely monitor and control from a pc connected to the internet. Refer to separate Suggested Specification.
**ADDITIONAL REQUIREMENTS**

**Withstand and Closing Ratings**

A. The ATS shall be rated to close on and withstand the available rms symmetrical short circuit current at the ATS terminals with the type of overcurrent protection shown on the plans. WCR ATS ratings as be as follows when used with specific circuit breakers:

<table>
<thead>
<tr>
<th>ATS SIZE</th>
<th>WITHSTAND &amp; CLOSING RATING W/CLF</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>22,000A</td>
</tr>
<tr>
<td>70 - 200</td>
<td>22,000A</td>
</tr>
<tr>
<td>230</td>
<td>22,000A</td>
</tr>
<tr>
<td>260 – 400</td>
<td>42,000A</td>
</tr>
<tr>
<td>600 – 1200</td>
<td>65,000A</td>
</tr>
<tr>
<td>1600 – 2000</td>
<td>85,000A</td>
</tr>
<tr>
<td>2600 – 3000</td>
<td>100,000A</td>
</tr>
</tbody>
</table>

**Tests and Certification**

- The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

- Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.

- The ATS manufacturer shall be certified to ISO 9001: 2000 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001: 2000.

**Service Representation**

- The ATS manufacturer shall maintain a national service organization of company-employed personnel located throughout the contiguous States. The service center’s personnel must be factory trained and must be on call 24 hours a day, 365 days a year.

- The manufacturer shall maintain records of each switch, by serial number, for a minimum of 20 years.

- For ease of maintenance, the transfer switch nameplate shall include drawing numbers and serviceable part numbers.
MEDIUM VOLTAGE CABLELING

SCOPE

- The scope of work shall cover supply, laying, connecting, testing and commissioning of low and medium voltage power and control cabling.

STANDARDS

- The following standards and rules shall be applicable:
  1) IS: 1554 Parts I & II

  All codes and standards mean the latest.

<table>
<thead>
<tr>
<th></th>
<th>Nominal system voltage</th>
<th>3.3/6.6/11/22KV</th>
<th>415Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>Type of system earthing</td>
<td>Effectively or non effectively earthed (EE/NEE)</td>
<td>Solidly earthed</td>
</tr>
<tr>
<td>c</td>
<td>Voltage grade of cable</td>
<td>Earthed or unearthed as applicable</td>
<td>1100 Volts</td>
</tr>
<tr>
<td>d</td>
<td>Conductor</td>
<td>Stranded aluminum</td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>Insulation</td>
<td>XLPE</td>
<td></td>
</tr>
<tr>
<td>f</td>
<td>No of cores</td>
<td>Single core,3cores</td>
<td>Single core 3,3.5 and 4 cores</td>
</tr>
<tr>
<td>g</td>
<td>Screening</td>
<td>Required</td>
<td>Not applicable</td>
</tr>
<tr>
<td>h</td>
<td>Inner sheath for multicore cable</td>
<td>Extruded PVC compound</td>
<td></td>
</tr>
<tr>
<td>i</td>
<td>Amour (when required)</td>
<td>Galvanized round steel wire/steel strip</td>
<td></td>
</tr>
<tr>
<td>j</td>
<td>Outer sheath</td>
<td>Extruded black PVC compound</td>
<td></td>
</tr>
<tr>
<td>k</td>
<td>Identification of cores</td>
<td>By numerals printed on the cores</td>
<td>By coloring of PVC Insulation</td>
</tr>
</tbody>
</table>

CABLES

- All cables shall be 1100 Volt grade XLPE insulated (as specified), sheathed with or without steel armouring as specified and with an outer XLPE protective sheath. All cables shall have Flame Retardant, Low Smoke Sheath (FRLS) and meet, ASTM norms for the smoke density and Oxygen Index norms. Cables shall have high conductivity stranded Aluminium or copper conductors and cores color coded to the Indian Standards.
- All cables shall be new without any kinks or visible damage. The manufacturers name, insulating material, conductor size and voltage class shall be marked on the surface of the cable at every 600mm centers.

INSTALLATION

- Cables shall be laid in the routes marked in the drawings. Where the route is not marked, the contractor shall mark it out on the drawings and also on the site and obtain the approval of the Architect/Consultant before laying the cable. Procurement of cables shall be on the basis of actual site measurements and the quantities shown in the schedule of work shall be regarded as a guide only.
• Cables, running indoors shall be laid on walls, ceiling, inside shafts or trenches. Single cables laid shall be fixed directly to walls or ceiling and supported at not more than 500 mm. Where number of cables are run, necessary perforated cable trays shall be provided wherever shown. Perforated cable trays shall be mild steel or Aluminium as specified in the schedule of work. Perforated trays shall not be directly suspended but supported on mild steel frame work as shown on drawing or as approved. Cables laid in built-up trenches shall be on steel supports. Plastic identification tags shall be provided at every 30m.

• Cables shall be bent to a radius not less than 12 (twelve) times the overall diameter of the cable or in accordance with the manufacturer’s recommendations whichever is higher.

• In the case of cables buried directly in ground, the cable route shall be parallel or perpendicular to roadways, walls etc. Cables shall be laid on an excavated, graded trench, over a sand or soft earth cushion to provide protection against abrasion. Cables shall be protected with brick or cement titles as shown on drawing Width of excavated trenches shall be as per drawings. Backfill over buried cables shall be with a minimum earth cover of 600mm. The cables shall be provided with cable markers at every 35 meters and at all loop points.

• The general arrangement of cable laying is shown on drawings. All cables shall be full runs from panel to panel without any joints or splices. Cables shall be identified at end terminations indicating the feeder number and the Panel/Distribution board from where it is being laid. All cable terminations for conductor up to 4 sqmm may be insertion type and all higher sizes shall have tinned copper compression lugs. Cable terminations shall have necessary brass glands and all joints shall be double compression type whether so specified or not. The end terminations shall be insulated with a minimum of six half-lapped layers of PVC tape. Cable armouring shall be earthed at both ends.

• Application for Armoured and Unarmoured cables

Armoured power and control cables should be used where

✓ Cables are laid fully outdoor, i.e. connections from outdoor equipment to outdoor equipment
✓ Cables are laid partly outdoor, i.e. connections from outdoor equipment to indoor Equipment

Unarmoured power and control cables should be used where cables are fully laid indoors, i.e. connections from indoor equipment to indoor equipment.

SIZING CALCULATION

• Power cables should be sized to meet the short circuit for the expected breaker operating time (0.2/0.6/1.0 secs as the case may be)

• Power cables should also be sized to carry the normal circuit load current without exceeding the conductor temperature (70° for PVC and 90° for XLPE). The derating factors to be considered for this purpose are-ambient derating, group derating for laying conditions. The minimum Derating can be limited to 0.75. The higher of the size obtained by the above two methods should be selected. For multiple run cables, each run should be capable of meeting the short circuit withstand.

• The size should be cross-checked for voltage drops, based on the application, and should be increased, if need be, to limit voltage drops to desired levels.

• Control cables

The control cables should be according to the following specification:

1. Applicable standard IS 1554 (Part1)
2. Voltage grade 1,100 Volts
3. Conductor material Annealed, high conductivity copper (stranded)
4. Conductorsize 2.5 Sqmm having 7 strands of 0.67mm dia
   1.5 Sqmm having 7 strands of 0.5mm dia
4.0 Sqmm stranded conductor for CT leads

5. No of cores Multicore as required
6. Insulation Extruded PVC compound
7. Insersheath Extruded PVC compound
8. Armour Galvanized around steel wire /strips wherever Required as per clause
9. Outersheath Extruded black PVC compound

- Instrumentation cables
  1. Conductor: Annealed tinned copper conductor in stranded circular construction of 0.8 or 0.5 Sqmm
  2. Insulation: Extruded PVC or Elastomer
  3. Insulation resistance: Minimum 500 megohm per km at 20°C
  4. Core wrapping: By taping or extrusion of non-hydroscopic material
  5. Core screening: By copper or copper laminated plastic tape
  6. Rip cord: Nonmetallic under core wrapping
  7. Drain wire: Tinned copper wire of minimum 0.5 Sqmm cross section in contact with screen
  8. Cabling elements: Two/three/four insulated conductors twisted together
  9. Overall screening or individual pair screening: By tinned copper wire braids of 0.15mm diameter for minimum 85% coverage. Foil screen should not be used
  10. Inner sheath if Armouring is provided: Extruded PVC compound
  11. Armour (if required): Galvanized steel wire/strip
  12. Outer sheath: Extruded grey PVC compound (Grey should be used to differentiate this from power and control cable)

- Installation Checklist
  Implementation of the following installation requirements should be checked

- Mode of cabling laying
  1. Switchyard and outlying areas: Cable trenches and/or directly buried if no strong chemical Contaminants present in the soil.
  2. Indoor switchgear rooms located in ground floor: Cable trenches
  3. Process plants and utility: Cable trays with conduits for branch off connections. Cable trenches may be provided wherever required.
  4. Conveyor belts: Cable trays run along conveyor structures
  5. Road/rail crossings and Oil/gas/water Sewage pipes crossing: Through buried hume pipes or overhead cable rack
  6. Hotels: Above false ceiling, laid in cable trays supported from roof slab.

- Directly buried cables
  1. Minimum depth of burial should be 750mm for 1100V grade cables and 900mm for 3.3/6.6/11/22KV cables
  2. Cable route markers and protective covers should be provided

- Cables laid in cable trenches
  1. Dimensions of RCC cable trenches should be in accordance with the number of cable racks to be provided
  2. Cables should be laid on MS painted carrier racks supported from walls of the trench
  3. Outdoor cable trenches should have RC covers and in door cable trenches should have chequered plats covers.
  1. Cables laid on cable trays/racks Cable trays
Cable trays should be made of 14 gauge (2 mm) MS sheet / Galvanized steel.

2. Standard dimensions should be as follows:
   - Width: 150mm, 300mm, 450mm, and 600mm
   - Height: 100mm
   - Length: 2500mm

3. Ladder type trays should be used for power cables and perforated type for control and instrument cables. Cable trays should be painted with one coat of primer and two coats of paint.
   - Cable installation on trays/racks
     1. HV cables should be laid in the bottom tier and cables of subsequent voltage grades in higher tiers of trays.
     2. Control and instrument cables shall be laid in trays separated from power cable trays.
     3. Power cables should be laid in a single tier only in each tray/rack.
     4. Control and instrument cables can be laid up to two layers in each tray/rack.
     5. Single core cables should be laid in trefoil group with a spacing equal to diameter of the cable (1D) between edges of the trefoils.

6. These should be held on tray/racks by trefoil clamps.
   - 3 core HV cables should be laid with 1D spacing.
   - 3 core and 4 core MV cables should be laid in touching formation.
   - All cables should be secured on the Cable trays/racks.

Bending radius of Cables
1. The bending radius for cable should not be less than:
   - Voltage Rating (KV) | PVC & XLPE Cables Armoured/Unarmoured
   - Single Core | Multi Core
   - Up to 1.1 | 15D | 12D
   - Above 1.1 | 15D | 15D
   Where D is the outer diameter of the cable.

Cable Installation Practices
1. Cables to each circuit shall be laid in one continuous length. Cable jointing and splicing should be avoided.
2. The following clearances should be kept between different types of cables:
   - Power cable to control cable: 200mm
   - Power cable to communication cable: for multi core power cables for single 300mm Core power cables: 460mm
   - Power cable to gas/water pipes: 300mm
3. All cables should be secured by clamping along walls, ceilings, columns, structures etc., and on emerging from trenches, trays, embedded conduits before they are connected at equipment terminals/junction boxes. They should also be tied with nylon cord on horizontal cable trays and clamped on vertical raceways at regular intervals.
4. All cables should be tagged. The tags should be put at 30 meters interval on long runs of cable.
5. Cables above false ceilings should be clipped along walls or taken on trays suspended from ceiling.
6. Where joints become necessary, the same should be done by proper connectors. Taped joints in cables/wires should not be permitted.
7. Termination
   - All cable terminations should be of the solventless crimping type.
   - Identification tags made from aluminum sheet should be attached to each end of each cable by means of GI wire.

8. All floor and wall openings for cable trays should be sealed by fire proof compound.
   - Waterproof sealing should be done for pipe inserts in floor slab, walls etc.
• Terminations and joints
  1. HV Terminations and joints
     ✓ The cable terminations and cable joints for 6.6KV to 33KV systems should be of the heat shrinkable type. Stress control and stress grading, wherever necessary, in the terminations and joints should be by means of semi-conducting heat shrinkable tubing
     ✓ The cable should be clamped securely before it is taken in to termination or joints kits
     ✓ The armour of the cable should be connected to the earth bus
     ✓ For outdoor installation, outdoor type cable termination kit should be used.

• Cable glands
  1. Cable glands for both HV and MV systems should be cadmium nickel plated and passivated to protect against corrosion and chemical vapours. The glands should be of the double seal cone grip type
  2. For hazardous areas, flameproof glands should be used
  3. The cable glands should be suitable for various types and sizes of cables used

• Cable lugs
  1. The cable lugs for connecting the cables to equipment terminals should be of the tinned copper, compression type suitable for the specified conductor sizes
  2. The current rating of the lugs should be the same as that of the Respective cable conductors
  3. The bolted power cable connections at the equipment terminals should be covered with removable shrouds to prevent contact with live parts

• Earthing
  1. The Armour of multi core power and control cables should be earthed at both equipment and switchgear end
  2. The Armour of single core power cables should be earthed at switchgear end
  3. For instrumental cables, the screens/shield should be earthed at both ends. To avoid circulating current through the shield, equiv. potential bonding of the enclosures at both the ends should be done. However, if circulating current is experienced, the earthing should be done according to the manufacture’s recommendation
  4. The cable tray sections should be bonded together and cable trays should be earthed at every 10 meter length

• Bus Trunking
  1. Phase sequence: Phase sequence of the connected equipment should be the same
  2. Joints
     ✓ Tightness of all bus bar joints should be checked with a torque wrench
     ✓ Carefully check expansion joints in the bus ducts enclosure, if such joints are provided
     ✓ Outdoor bus ducts enclosure joints carefully be water tight
  3. Earthing of bus duct enclosure
     ✓ An earth bus should be run along the entire length of the bus enclosure
     ✓ Each section of the enclosure should be bonded to the earth bus
     ✓ The bus duct support structure should be bonded to the earth bus
     ✓ The earth bus should be connected to the earth grid at minimum two points. However for long bus ducts, the earth bus should be connected to the earth grid at intervals of 10 meters

• Installation Check List
  1. Phase sequence: Phase sequence of the connected equipment should be same
  2. Joints
     ✓ Tightness of all bus bars joints shall be checked with a torque wrench.
     ✓ Checked carefully expansion joints in the busway for tightness, if such joints are
3. Earthing of busway enclosure
   ✓ An earth bus shall be run along the entire length of the bus way
   ✓ Each section of the enclosure shall be bonded to the earth bus

- O & M Checklist
  The following checks and tests should be carried out and record should be maintained including records of repairs and maintenance works carried out
  1. Monthly checks
     ✓ General: Check the route for buried cables. If any portion of the cable has been exposed due to soil erosion, gardening etc, take remedial measures to bury and cover it properly
     ✓ HV Cable boxes: Check general condition of boxes and clean them, Check for leakage of compound, for compound filled boxes & Check for flashover marks near the insulators and earthing bonds
  2. Yearly Checks on HV Cables Boxes
     ✓ Clean insulators and repair chipped spots
     ✓ Check compound level and fill up to the proper level
     ✓ Tighten connection, bolts and screws in the dividing box
     ✓ Check earth connections for tightness and earth resistance for the supports structure
  3. Annual checks for HV and major 415V cables
     ✓ Check insulation resistance
     ✓ Check cable terminals and tighten connections

- Cable trays and trenches
  1. Annual Check
     ✓ Clean all cable trays and trenches
     ✓ Check Earthing connections of all cable trays

- Bus Trunking
  1. Annual Check
     ✓ Clean the interior of the bus duct and support insulator
     ✓ Check the insulators for any breakage/cracks
     ✓ Tighten all bolted joints on the bus bars
     ✓ Tighten all bolted joints on the bus enclosure
     ✓ Check that all earth connections are tight and in order

- O & M Checklist: Sandwich Subways Annual
  1. Megger test
  2. High voltage test 2.5 kv for one min

TESTING
- MV cables shall be tested upon installation with a 500V Meggar and the following readings established:
  1. Continuity on all phases
  2. Insulation Resistance
     ✓ Between conductors
• All conductors and ground

• All test readings shall be recorded and shall form part of the completion documentation.

MODE OF MEASUREMENT

• Cable will be measured on the basis of a common rate per unit length indoor or outdoor and shall include the following:
  • For cables laid indoors:
    1. Cables and clamps
    2. Installation, commissioning and testing
    3. Cable marking OR
  • For cable buried underground:
    1. Cables and protective bricks & tiles
    2. Installation, commissioning & testing
    3. Cable markers
  • Cable trays/racks will be measured on the basis of unit length for individual sizes and shall include
    1. Aluminium perforated tray M.S framing supporting the Aluminium tray.
    2. Installation and painting in 2 coats of black bituminous paint on one coat of red oxide primer.
  • Each cable termination will be measured as one unit for payment. Certain cable sizes are grouped together and rates shall be furnished against each group. The item shall include the following:
    1. Lugs, glands, bolts, nuts
    2. All jointing materials
    3. Installations, testing and commissioning
    4. Earthing the glands
  • For cables buried underground excavation shall be paid for additionally for the following per unit volume:
    1. Excavation and back filling
    2. 6" Soft Earth Cushioning below and above cable
  • The cost of laying protective tiles shall be part of cable cost as stated above.
**DISTRIBUTION BOARDS**

**SCOPE**
- The scope of work shall cover the supply, installation, testing and commissioning of lighting and power distribution boards. Associated minor civil works required for the erection of the DB’s such as opening in wall etc. are also included in the scope of this contract.

**STANDARDS**
- The following standards and rules shall be applicable:
  1. IS 8828-1978 Miniature Circuit Breaker.
  2. Indian Electricity Act 1910 & Rules Issued there Under
- All codes and standards mean the latest. Where not specified otherwise the installation shall generally follow the Indian Standard Codes of Practice.

**DISTRIBUTION BOARDS**
- Distributions boards along with the controlling MCB’s or Isolator as shown shall be fixed in a mild steel Box with hinged lockable door suitable for recessed mounting in wall. Distribution boards shall be made of 16 SWG sheet steel duly rust inhibited through a process of degreasing, acid pickling, phosphate and powder coated to an approved color over a primer.
- All components shall be mounted on DIN rails and covered totally with a sheet steel cover rendering it finger-safe. Access to the internal connections shall be only through removing the cover sheet.
- Three phase boards shall have phase barriers and a wire channel for internal wiring. All DB’s shall be internally prewired using copper insulated high temperature PVC wires brought to a terminal strip of appropriate rating for outgoing feeders.
- Conduit knockouts shall be provided as required/shown on drawings and the entire board shall be rendered dust and vermin proof with necessary sealing gaskets.
- MCB’s shall have quick make and break non-welding self wiping silver alloy contacts for 9KA short circuit both on the manual and automatic operation. Each pole on the breaker shall be provided with inverse time thermal over load and instantaneous over current tripping elements, with trip-free mechanism. In case of multiple breakers, the tripping must be on all the poles and operating handle shall be common. Breakers must conform to IS 8828 with facility for locking in OFF position. Pressure clamp terminals for stranded/solid conductor insertion are acceptable upto 4 sqmm Aluminium or 2.5 sqmm copper and for higher ratings, the terminals shall be suitably shrouded. Wherever MCB isolators are specified they are without the tripping elements.
- Boards shall meet with the requirements of IS 2675 and marking arrangement of busbars shall be in accordance with IS 375. Bus Bars shall be of copper and rated for the incomer switch rating and sized for a temperature rise of 30deg. Cover the ambient. Neutral and earthbars shall be of copper and rated as follows:

<table>
<thead>
<tr>
<th></th>
<th>Neutral</th>
<th>Earth</th>
<th>Bar</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDB’s</td>
<td>Same as phase</td>
<td>Same as phase</td>
<td></td>
</tr>
<tr>
<td>PDB’s</td>
<td>1.5xphasebar</td>
<td>Same as neutral bar</td>
<td></td>
</tr>
</tbody>
</table>

There shall be one earth terminal for single phase boards and 2 for 3 phase boards. Circuit diagram indicating the load distribution shall be pasted on the inside of the DB as instructed.
- In the case of MCB distribution boards, the backup fuses wherever shown shall be not less than 63A with a delayed characteristic and a minimum prearcing time of 0.5sec. at 9KA fault current.
- All outgoing feeders shall terminate on a terminal strip which in turn is prewired to the MCB by means of insulated single conductor high temperature PVC copper wires as follows:

<table>
<thead>
<tr>
<th></th>
<th>LDB’s</th>
<th>PDB’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 15A</td>
<td>2.5 sqmm</td>
<td>4.0 sqmm</td>
</tr>
<tr>
<td>25A</td>
<td>6.0 sqmm</td>
<td></td>
</tr>
</tbody>
</table>
- Each DB shall have indicating lamps preferably neon type denoting power availability in the board after the switch. Indicating lamps shall be complete with fuses.

- In the case of Dimmer DB’s, the DB’s shall incorporate the Dimmer panels as a part of the DB generally as shown on drawing and as approved.

**INSTALLATION & TESTING**

- All distribution boards shall be mounted on wall or recessed, with necessary angle iron frame work. All mounting frames shall have one prime coat and two finish coats after the completion of the work. All distribution boards shall be touched up for damaged painting.

- All boards shall be meggered phase to phase and to neutral using 1000V megger with all switches in closed position. The megger value should not be less than 2.5 megaohms between phases and 1.5 megohms between phase and neutral.

- Fabrication drawings of all boards shall be approved by the Consultants before fabrication and the boards inspected before dispatch, unless waived in wiring.

**MODE OF MEASUREMENT**

- The distribution board complete with the various components specified, indicating lamps, supporting frame, internal wiring, erection etc., will be treated as one unit for the purpose of measurement and payment.

- DB’s with dimmers shall be separately counted.

**CONDUIT WIRING**

**SCOPE**

- The scope of work shall cover supply, installation testing and commissioning of all conduit wiring.

**STANDARDS**

- The following standards and rules shall be applicable
  1. IS: 732 Code of Practice for Electrical wiring installation (System voltage not exceeding 650V)
  2. IS: 1646 Code of Practice for fire safety of building (General) Electrical Installation.
  3. IS: 3480 Flexible steel conduits for electrical wiring
  4. IS: 3837 Accessories for rigid steel conduit for electrical wiring
  5. IS: 694 PVC insulated cables
  6. IS: 6946 Flexible (Pliable) non-metallic conduits for electrical installation
  7. IS: 1293 3 pin plugs and sockets
  8. IS: 8130 Conductors for insulated electric cables and flexible cord
  9. IS: 9537 Specification for conduits for Electrical Installations
  10. Indian Electricity Act 1910 and rules issued thereunder.
  11. Regulations for the electrical equipment in buildings issued by the Tariff Advisory Committee of the Insurance Association of India.

- All standards and codes mean the latest.

**RIGID AND FLEXIBLE CONDUITS**

- Conduits can be
  1. mild steel - black enameled
  2. mild steel - Galvanized
  3. Rigid PVC

- PVC conduits shall be used only where the conduits are embedded in concrete or wall chases.

- Flexibility conduits shall be formed from a continuous length of spirally wound interlocked strip steel with a fused zinc coating on both sides. The conduit shall be terminated in brass or PVC adapters. PVC flexible conduits shall not be used.
• Accessories
Conduit fittings such as bends, elbows, reducers, chase nipples, split couplings, plugs etc. shall be heavy duty specifically designed and manufactured for their particular application and in accordance with relevant I.S.S. Wherever Galvanized conduits are specified in the schedule of work, the fittings also shall be Galvanized; Likewise PVC fittings.

• Wires
All wires shall be single core multi-strand copper or single strand Aluminium. PVC insulated to IS: 694 and shall be 1100V grade as specified and required in the schedule of work.
All wires shall be color coded as follows:

<table>
<thead>
<tr>
<th>Phase</th>
<th>Color of wire</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>Red</td>
</tr>
<tr>
<td>Y</td>
<td>Yellow</td>
</tr>
<tr>
<td>B</td>
<td>Blue</td>
</tr>
<tr>
<td>N</td>
<td>Black</td>
</tr>
<tr>
<td>Earth</td>
<td>Green (insulated)</td>
</tr>
<tr>
<td>Control (if any)</td>
<td>Grey</td>
</tr>
</tbody>
</table>

• Switches & Sockets
Switches shall be moulded plate type of modular design with silver-plated contacts. Sockets shall be 3 pins with switch and plate type cover. All switch & socket mounting boxes shall be 16 SWG Galvanized steel or PVC specially made for the switches and sockets used. Combination of multiple switch units and sockets should be used in appropriate manner to minimise the switch boxes.
Weather and waterproof switches / sockets shall be used in all outdoor situations and bathrooms.
For heavy duty, metal clad sockets with MCB isolator mounted in a Galvanized steel box shall be provided.

• Installation
The size of conduit shall be selected in accordance with the number of wires permitted under table given below. The minimum size of the conduit shall be 20 mm Dia unless otherwise indicated or approved. Size of wires shall be not less than 1.5 mm copper or 2.5 sq.mm aluminium, but as specified in the schedule of work.

<table>
<thead>
<tr>
<th>Nominal dia of wires (mm)</th>
<th>Nominal Cross sec. area(sqmm)</th>
<th>20 mm</th>
<th>25 mm</th>
<th>32 mm</th>
<th>38 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2.40</td>
<td>1.50</td>
<td>4</td>
<td>3</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>1/1.80</td>
<td>2.50</td>
<td>4</td>
<td>2</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>1/2.24</td>
<td>4.00</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>1/2.80</td>
<td>6.00</td>
<td>1</td>
<td>-</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>1/3.55</td>
<td>10.00</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>
S - runs of conduits which have distance not exceeding 4.25 m between draw boxes & which do not deflect from the straight by an angle more than 15 degree.

B - runs of conduits, which have, deflect from the straight by more than 15 degree.

1. Conduits shall be kept at a minimum of 100 mm from the pipes of other non-electrical services.

2. Separate conduits / raceways shall be used for each of the following:
   - Normal lights and 5A 3 pin sockets on lighting circuit
   - Power outlets - 15A 5 pin 20A / 25A 4 pin +scraping earth metal clad sockets
   - Emergency lighting
   - Telephones
   - Fire alarm system
   - Public address system
   - Call bell wiring

- Conduit layout shall be generally as indicated on drawings and the layout shall be supplemented and complemented by contractor on site with the approval of the Engineer.
- Wiring for short extensions to outlets in hung ceiling or to vibrating equipments, motors etc., shall be installed in flexible conduits. Otherwise rigid conduits shall be used. No flexible extension shall exceed 1.25m.
- Conduits run on surfaces shall be supported on metal 12 mm thick saddles which in turn are properly screwed to the wall or ceiling. Saddles shall be at intervals of not more than 500 mm. Fixing screws shall be with round or cheese head and of rustproof materials. Exposed conduits shall be neatly run parallel or at right angles to the walls of the building. Unseemly conduit bends and offsets shall be avoided by using fabricated mild steel junction/pull through boxes for better appearances. No crossover of conduits shall be allowed unless it is necessary and entire conduit installation shall be clean and neat in appearance.
- Conduits embedded into the walls shall be fixed by means of staples at not more than 500 mm intervals. Chases in the walls shall be neatly made and refilled after laying the conduit and brought to the finish of the wall but final finish will be done by the building contractor.
- Conduits buried in concrete structure shall be put in position and securely fastened to the reinforcement and got approved by the Engineer, before the concrete is poured. Proper care shall be taken to ensure that the conduits are neither dislocated nor choked at the time of pouring the concrete. Suitable galvanized steel fish wires of not less than 0.63 mm dia shall be drawn in all conduits before they are embedded. Where conduit passes through expansion joints in the building, adequate expansion fittings shall be used to take care of any relativemovement.
- Inspection boxes shall be provided for periodical inspection to facilitate withdrawal and removal of wires. Such inspection boxes shall be flush with the wall or ceiling in the case of concealed conduits. Inspection boxes shall be spaced at not more than 12 meters apart or two 90 degree solid bends or equal. All junction and switch boxes shall be covered by 6mm clear Perspex plate truly cut and fixed with cadmium plated brass screws. These junction boxes shall form part of point wiring or conduit wiring as the case may be including the cost of removing the Perspex cover for painting and refixing. No separate charges shall be allowed except where specially mentioned.
- Conduits shall be free from sharp edges and burs and the threading free from grease or oil. The entire system of conduits must be completely installed and rendered electrically continuous before the conductors are pulled in. Conduits should terminate in junction boxes of not less than 32mm deep.
- An insulated earth wire of not less than 2.5 sq.mm aluminium or copper shall be run in each conduit as specified in the schedule of work.
LIGHTING & POWER WIRING

- All final branch circuits for lighting and appliances shall be single conductor cables run inside conduits. The conduit shall be properly threaded and screwed into sockets, bends, and junction boxes. No part of the wiring shall be open without a suitable conduit piping.
- Branch circuit conductor sizes shall be as shown in the schedule of quantities and or drawings.
- Final branch circuits shall preferably be kept in a separate conduit up to the Distribution Board. No other wiring shall be bunched in the same conduit except those belonging to the same phase. Each lighting branch circuit shall not have more than ten outlets whichever is lower or as shown on drawings. Each conduit shall not hold more than three branch circuits.
- Flexible cords for connection to appliances, fans and pendants shall be 660/1000V grade (three or four cores i.e. with insulated neutral wire of same size) with tinned stranded copper wires, insulated, twisted and sheathed with strengthening cord. Colour of sheath shall be subject to the Engineer’s approval.
- Looping system of wiring shall be used. Wires shall not be jointed. Where joints are unavoidable, they shall be made through approved mechanical connectors. No such joints shall be made unless the length of the sub-circuit, sub-main or main is more than the length of the standard coil.
- Control switches shall be connected in the phase conductors only and shall be ‘ON’ when knob is down. Switches shall be fixed in 3 mm thick Galvanized steel boxes with cover plates as specified. Cadmium plated brass screws shall be used.
- Power wiring shall be distinctly separate from lighting wiring. Conduits not less than 25 mm and wires not less than 2.5 sq.mm aluminium/copper shall be used as specified in the schedule of work.
- Every conductor shall be provided with identification ferrules at both ends matching the drawings.

TESTING

- The entire installation shall be tested for:
  1. Insulation resistance
  2. Between phases
  3. Between each phase and earth
  4. Earth continuity
  5. Polarity of single pole switches
- No installation shall be commissioned unless and until the insulation resistance is 2.0 mega ohms between phases and 1.0 mega ohms between phase and neutral. All tests shall be witnessed by the Engineer-in-charge and attested.
- A test certificate shall be submitted as per IS 732.
- Mode of measurement
LIGHT FIXTURES

SCOPE

- The scope of work shall cover the supply, installation and testing of fluorescent and incandescent light fixtures and ceiling fans.
- Where fixtures are supplied, the scope shall cover installation only with all the accessories as specified in the schedule of work.

STANDARDS

- The following standards and rules shall be applicable:
  2. IS: 1913 – 1969 General and Safety requirements for electric lighting fittings.
  3. IS: 8030 – 1976 Luminaries for Hospitals
  5. Indian Electricity Act and Rules issued thereunder.
- All codes and standards mean the latest. Where not specified otherwise the installation shall generally follow the Indian Standard Codes of Practice.

GENERAL REQUIREMENTS

- All fixtures shall be complete with accessories and fixings necessary for installation whether so detailed under fixture description or not.
- Fixture housing, frame or canopy shall provide a suitable cover for the fixture outlet box or fixture opening.
- Fixtures shall be installed at mounting heights as detailed on the drawings or instructed on site by the Architects/Consultants and individually earthed with 2.5 Cu wire.
- Fixtures and/or fixture outlet boxes shall be provided with hangers to adequately support the complete weight of the fixture. Design of hangers and method of fastening other than shown on the drawings or herein specified shall be submitted to the Architect/Consultant for approval.
- Pendant fixtures within the same room or area shall be installed plumb and at a uniform height from the finished floor. Adjustment of height shall be made during installation as per Architect’s/Consultant’s instructions.
- Flush mounted and recessed fixtures shall be installed so as to completely eliminate light leakage within the fixture and between the fixture and adjacent finished surface.
- Fixture mounted on outlet boxes shall be tightly secured to a fixture stud in the outlet box. Extension pieces shall be installed where required to facilitate proper installation.
- Fixture shall be completely wired and constructed to comply with the regulations and standards for Electric Lighting Fixtures, unless otherwise specified. Fixtures shall bear manufacturer’s name and the factory inspection label unless otherwise approved.
- Wiring within the fixture and for connection to the branch circuit wiring shall be not less than 1.5 sq mm copper for 250 volt application. Wire insulation shall suit the temperature conditions inside the fixture and wires bypassing the choke shall be heat protected with a heat resistant sleeve.
- Metal used in lighting fixtures shall be not less than 22 SWG or heavier if so required to comply with the specification or standards. Sheet steel reflectors shall have a thickness of not less than 20 SWG. The metal parts of the fixtures shall be completely free from burrs and tool marks. Solder shall not be used as mechanical fastening device on any part of the fixture.
- Ferrous metal shall be bonderized and given a corrosion resistant phosphate treatment or other approved rust inhibiting prime coat to provide a rust-proof base before application of finish.
- Non-reflecting surfaces such as fixture frames and trim shall be finished in baked enamel paint.
- Light reflecting surface shall be having a reflection factor of not less than 80%. All parts of reflector shall be completely covered by finish and free from irregularities. Finish shall be capable
of withstanding 72 hours continuous exposure to an ultraviolet sun lamp placed 10 cm from the surface without discoloration, hardening or warping and retain the same reflection factor after exposure. Test results shall be furnished for each of fixtures.

- Fixture with visible frames shall have concealed hinges and catches. Pendant fixtures and lamp holders shall be provided with ball type aligners or similar approved means. Recessed fixtures shall be constructed so as to fit into an acoustic tile ceiling or plaster ceiling plaster rings/flanges shall be provided for plaster ceiling. Fixtures with hinged diffuser doors shall be provided with spring clips or other retaining device to prevent the diffuser from moving.
- Detailed catalogue cuts for all fixtures, or, if so required by the Architect/Consultants sample fixtures shall be submitted for approval to the Architect/Consultants before orders for the fixtures are placed. Shop drawings for non-standard fixture types shall be submitted for approval to the Architect/Consultant.
- Recessed fixtures shall be constructed so that all components are replace-able without removing housing from the ceiling.
  1. Lamp shall be supplied and installed in all lighting fixtures furnished under this contract. All lamps shall be rated for 250 volts.
  2. Lamps used for temporary lighting service shall not be used in the final lamping of fixtures units.
  3. Lamps shall be of wattage and type as shown on the drawings and schedule. Where not shown, the details shall be ascertained from the Architect/Consultant before procurement.
  4. Lamps for permanent installation shall not be placed in the fixtures until so directed by the Architect/Consultant, and this shall be accomplished directly before the building portions are ready for occupation.

**FLUORESCENT FITTINGS**

- Only single and/or two lamp ballast shall be used in any one fixture. All ballasts shall be low loss electronic ballasts unless specified otherwise.
- All fluorescent fixtures shall be provided with separate wiring channel with cover plate and an earth terminal. All screws shall be chromium brass screws. Lamp and starter holders shall be out of tough moulded plastic with spring loaded rotor type contactors rendered shock and vibration proof. Condensers shall be low loss paper impregnated hermetically sealed complying with IS 1969-196. Internal wiring shall be neatly clipped and where by passing the ballast, a suitable heat resistant barrier or sleeve shall be provided.
- Surface mounted fixtures longer than two feet shall have one additional point of support besides the outlet box fixture stud when installed individually. Pendant individually mounted fixtures four feet long and smaller shall be provided with twin stem/conduit hangers. Stems shall have ball aligners or similar devices and provided for a minimum of 25 mm vertical adjustment. Stems shall be of appropriate length to suspend fixtures at required mounting height.
- Lamps shall have bi-pin bases and a minimum approximate rated and guaranteed life of 6000 hrs. Color spectrum of light shall be equivalent to ‘Philips White.’

**INCANDESCENT FITTINGS**

- Incandescent fittings shall be of the type generally specified on the drawings. Contractor should have sample approved by Architects/Consultant before procurement.
- Incandescent fixtures shall be equipped with porcelain, medium base, screw type sockets for lamps up to and including 200 watt and mogul/screw type base for lamps 300 watt and over.
- Relamping the fixture shall be possible without having to remove the fixture from its place.
- Incandescent lamps shall be inside frosted or clear type as required by the Architect/Consultants.
MODE OF MEASUREMENT

- Each fixture shall be measured as a unit complete with accessories, lamp, connectors, earthing, mounting arrangement, clamps etc.
- Suspension stems for light fittings shall be measured as bare conduits and paid at the rate per unit length.
- Where light fixtures are supplied by the client, the installation shall be paid per unit and the cost shall include all suspension, and installation materials.
EARTHING SYSTEM

SCOPE
- The scope of work shall cover earthing stations, laying G.I. / pipes and connecting the power panels, DBs and switch boards.

STANDARDS
- The following standards and roles shall be applicable:
  1) IS: 3043 - 1966 Code of Practice for earthing.
  2) Indian Electricity Act and Rules
- All codes and standards mean the latest. Where not specified otherwise the installation shall generally follow the Indian Standard Code of Practice.

MAINTENANCE FREE CHEMICAL EARTHING STATION
- The earthing station shall be as shown on the drawing. The earth electrodes shall be 40 mm dia GI/CU pipes plate. The earth resistance shall be maintained with a suitable crystalline conductive materials and back fill compound.
- The resistance of each earth station should not exceed 1 ohms.
- The earth lead shall be connected to the earth pipe through copper/brass bolts.
- The chemical earth station shall be as shown on the drawing and shall be used for equipment protective earthing grid.
- The earth electrodes shall be galvanized pipes 3.0 long with 40 mm dia.
- Crystalline Conductive material-Mixture of nature minerals and a chemical compound, highly conductive and non-corrosive, which prevents the inner pipe from corrosion and dissipates the current evenly.
- Back fill compound - Moisture retaining compound having 13 times more (Hygroscopic) water retaining capacity than its dry volume.
- The earth lead shall be fixed to the pipe with a clamp and safety set screws. The clamps shall be permanently accessible.

EARTH LEADS AND CONNECTIONS
- Earth lead shall be bare copper or aluminium or Galvanized steel as specified with sizes shown on drawings. Copper lead shall have a phosphor content of not over 0.15 percent.
- All earth strip shall be jointed as follows:
  - Copper : Copper riveting with 80mm fish plate and brazing
  - Aluminium : Riveting with 2Nos 100mm long bimetal fish plates using copper rivets GalvanizedSteel : Lap welding with 50mm minimum lap
- All strips shall be run on walls/beams with 6mm thick Galvanized steel earth saddles at 500mm centre to centre as shown on drawings.

EQUIPMENT EARTHING
- All apparatus and equipment transmitting or utilising power shall be earthed in the following manner:

<table>
<thead>
<tr>
<th>Size of phase conductor</th>
<th>Copper</th>
<th>Aluminium</th>
<th>Galvanized Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 16</td>
<td>&lt;</td>
<td>Same</td>
<td>1.55</td>
</tr>
<tr>
<td>Over 16 to 35</td>
<td>&lt;</td>
<td>16</td>
<td>32</td>
</tr>
<tr>
<td>Over 35</td>
<td>&lt;</td>
<td>As shown on drgs.</td>
<td>&gt;</td>
</tr>
<tr>
<td>Minimum (base)</td>
<td>2.5</td>
<td>4.0</td>
<td>6</td>
</tr>
</tbody>
</table>
The protective earth continuity conductor may be drawn inside the conduit in which case, it should be insulated.

Copper earth wires shall be used where copper wires are specified. Aluminium wires may be used where aluminium phase wires are specified unless otherwise indicated in the schedule of work and drawings.

Metallic conduit shall not be accepted as an earth continuity conductor. A separate insulated/bare earth continuity conductor of size related to phase conductor shall be provided. Non-metallic conduit shall have an insulated earth continuity conductor of the same size as above. All metal junction and switch boxes shall have an inside earth stud to which the earth conductor shall be connected. The earth conductor shall be distinctly coloured (green) for easy identification.

Armoured cables shall be bonded to the earth by 2 distinct earth connections to the armouring at both the ends and the size of connection being as above. In multiple cables entering a panel/DB, the cable joints shall be bonded together using a bonding wire selected on the basis of the largest size of cable in the group. In the case of unarmoured cable, an earth continuity conductor shall either be run outside along the cable or should form a separate insulated core of the cable. 3 Ph. power panels and distribution boards shall have 2 distinct earth connections of the size correlated to the incoming cable size. In case of 1 Ph. DB’s a single earth connection is adequate. Similarly for 3 Ph and 1 Ph. isolating switches there shall be 2 and 1 earth connections respectively, sizes being correlated to the incoming cable.

3 Ph. motors and other 3 Ph. apparatus shall have 2 distinct earth connections of size equal to incoming feeder size. For 1 Ph. motor and 1 Ph. apparatus, the single earth connections shall be provided of the above size.

**ELECTRICAL INSTALLATION**

All work shall be carried out in accordance with local Electrical Inspectorate, and IS Code of Practice 732. Reference to above codes, specifications and regulations shall mean the latest.

All materials used on the installation shall be new and of approved make. Tenderer should indicate makes of materials proposed to be used on the job.

**TESTING**

The following earth resistance values shall be measured with an approved earth megger and recorded.

1. Each earthing station
2. System as a whole
3. Earth continuity

**MODE OF MEASUREMENTS**

Providing earthing station complete with excavation, electrode, watering pipe, soil treatment, masonry chamber with cast iron cover etc. shall be treated as one unit of measurement.

The following items of work shall be measured and paid per unit length covering the cost of the earth wires/straps clamps, Labour etc.
1. Main protective earth terminal and connections to the earthing stations
2. Connections to the switchboard, power panels, distribution boards etc.
   - The cost of earthing the following items shall become part of the cost of the item itself and no separate payment for earthing shall be made.
   1. Motors - Earthing forming part of the cabling/wiring for the motors.
   2. Isolating switches and starters should form part of mounting frame, switch starter etc.
   3. Light fittings - form part of installation of the light fittings.
   4. Conduit wiring - should form part of the wiring
   5. Cable Armouring - should form part of the cable termination.
   6. Street lighting - should form part of the external cable which shall incorporate a protective earth-conductor which shall be used for earthing of the pole etc.

LIGHTNING PROTECTIVE SYSTEM

SCOPE
- The scope of work under this section includes Supply, installation, connection, testing and commissioning of Lightning protection system as specified in the data sheets / BOQ / Schematics. A complete system shall comprise of lightning arrestors, performance recorders, copper / GI tapes, electrodes, etc.

STANDARDS APPLICABLE
- All equipment, material and components shall comply with the requirements of NBC 2016 and Electricity Rules with updated amendments. Standards and Regulations applicable in the area where equipment is to be installed shall also be followed.

GENERAL INSTRUCTIONS

Submissions
- A prior survey may be conducted to determine the protection level to be considered, the lightning conductor location, the down conductor routes, the earth termination system location and type.
- Site plan indicating earth pits, earthing strip routing, road cross overs etc.
- Shop Drawings showing the co-ordinate routing of air terminations, down conductors, test links etc. along with foundation earth terminations, methods of fixing etc.
- Drawing showing the nature, dimensions, materials and position of all components, earth electrodes, earth conductor etc.

Design Basis
- System will be designed with following factors:
  1. Annual Thunder Storm Days - 45
  2. Area of Premises (L x W) - 32.9 x 15.35 Mtr
  3. Down Conductor - 4
Air Terminal
- The protection system shall be based on copper spike rod conductor Air terminals. Air terminal must provide protection against direct lightning strikes covering a radial distance.
- The calculation of the protection radius must be based on the Protection Angle with respect to height.

Down Conductors
- The down conductor shall be designed to let the lightning current flow from air termination systems to earth termination system.
- The down conductor should be installed outside of the structure except in cases where external route in not feasible. In this case the down conductor may be routed inside a specific service duct running along the full height or part of the height of the building.
- The down conductor system effectiveness may be reduced by internal routing. While designing the system reduced effectiveness of lightning protection system, inspection and maintenance difficulties and the risks resulting from the entry of voltage surges in the structure shall be kept in view and given due importance. Down conductor shall consist of strips, braided cables, or round sections having minimum cross section area.
- Copper strip 2# 40 x 6 mm or cu strip shall be preferred for good conductivity and corrosion resistance.

Earthing Stations / Pits
- Earthing Pipe in pipe technology with ancillary materials shall be done by digging an 8" /10" dia hand bore 10.5’ deep sufficient to install the electrode in normal soil conditions. The space between the soil and the electrode is filled up with electrolyte material mixed with the dug out mother soil, along with water and tightly packed up to the base of the terminal.
- In rocky areas and under hard soil and sandy soil conditions the method of installation will be as specified by manufacturer. Installation shall include drilling, welding, reverting, brazing and nut bolting pipe when ever required in an approved manner with required materials such as nut bolts and washer etc. and with necessary brick masonry work as per the specification. (As per IS 3043 amended up to-date).
- As far as possible continuous strip shall be used but when ever jointing of strip is unavoidable, the jointing over lap portion must not be less than 21/2 times the width of the strip either welded/ brazed/soldered by all sides or overlap of 6 inch with two nut bolts/ riveting of adequate size with required washer and covered by anti corrosive paint as per approved jointing practice in the industry and as per directives from site engineer in-charge.

Testing
- The earthing shall be subjected to the following tests on completion of the installation:
  1. Earth resistance of electrodes
  2. Continuity of conductors, joints etc.

Mode of Measurements
- Earthing Station - Complete with machine bore, pipe, electrolyte material, soil treatment, masonry chamber with cast iron cover etc. shall be treated as one unit of
measurement.
- Earthing strips shall be measured on actual running meters; this shall include cutting, riveting, bolting, brazing, welding etc.

UNINTERRUPTED POWER SYSTEM

SCOPE
- The scope of work shall cover supply, erection, testing and commissioning of a static Uninterrupted Power System meeting the performance criteria under equipment schedule ESOS.

SYSTEM FEATURES
- The system shall be standard tried out product of an established manufacturer and shall compromise minimum number of components with maximum MTBF & minimum MTTR. The system shall have high operating efficiency, front access and self-diagnostics. There shall be sufficient redundancy in all vital parts achieving a breakdown-free operation of the system.
- The System shall essentially consists of following major components.
  - Thyristised SCR based converter.
  - Converter input, system battery contactor, system battery, maintenance bypass, static bypass input with circuit breakers.
  - Battery system
  - Microprocessor based Menu driven software for operation, control and management as well as microprocessor controlled diagnostics.
- All sections shall be incorporated in a 1.8 mm sheet steel cubicle type panel with dead-front access. The sheet steel shall be pre-treated for rust inhibition through a 7-tank process of degreasing and phosphating and adequately treated before being powder coated in an approved colour. Ventilation for the system shall be provided with adequate redundancy to maintain component temperature within the limits. All air entries shall be protected with cleanable filters. All heat producing devices shall be mounted on ample heat sinks.

THYRISTERISED SCR BASED CONVERTER
- The converter should be thyristered SCR based. The converter should have the following important features.
  1. Power conversion
  2. Battery charging
  3. Power factor improvement
  4. Current harmonic reduction
  5. Voltage regulation
  6. Transient recovery
  7. Automatic synchronization
  8. Over current protection
  9. Over temperature protection
  10. Control power failure protection
  11. Short circuit protection
  12. High speed switching to reduce heat
• Dissipation (6 KHz)
  1. Input current limiting through two line slide current transformers.
  2. Current limiting function of battery charging to prevent the battery from being damaged.
  3. Electronic automatic equalize charge timer selectable for 24 hours
     ✓ lead acid type or shows alkaline type.
• The converter should meet the with the following specifications in addition to other requirements stated herein.
  1. Input Voltage: The converter will be fed from the commercial source.

  2. The converter will meet the following specifications in addition to other requirements stated herein:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal voltage</td>
<td>415V, 3 phase/250, 1 phase</td>
</tr>
<tr>
<td>Voltage range</td>
<td>+15%/-30% AC</td>
</tr>
<tr>
<td>Nominal frequency</td>
<td>50HZ ± 10%</td>
</tr>
<tr>
<td>Frequency range</td>
<td>± 5% (± 2.5 Hz)</td>
</tr>
<tr>
<td>Input power factor</td>
<td>0.98 lagging or more at full load</td>
</tr>
<tr>
<td></td>
<td>(PF improvement)</td>
</tr>
<tr>
<td>Input harmonic current THD</td>
<td>&lt;5% at 100% load</td>
</tr>
<tr>
<td></td>
<td>6% maximum at 50% load</td>
</tr>
<tr>
<td>Duty</td>
<td>Continuous at 40 deg. C</td>
</tr>
<tr>
<td>Cooling</td>
<td>Forced cooling using fans with thermal relays using a latched cut out for resetting as protection for cooling fans. Each individual fan has its own thermal relay.</td>
</tr>
<tr>
<td>Ambient operating temperature range</td>
<td>0 to 40 0C maximum</td>
</tr>
<tr>
<td>Operating Humidity</td>
<td>0-95% non-condensing</td>
</tr>
</tbody>
</table>
Operating altitude | Sea level to 1,000 meters
---|---
Magnetised sub-cycle inrush current | Typically 8 times normal full load current.
Converter walk-in time | 1 through 60 seconds (every 1 second selectable, 0 to 100% rated load) Default setting: 20 seconds.
Input | Suitable terminals are provided for termination of cables from the AC distribution board supplied by owner.

### STATIC INVERTER
- The static inverter should be of solid-state type with proven pulse width modulation technique. The inverter should utilize insulated gate bipolar transistor or power module transistor.
- The inverter should incorporate following essential features.
  1. Voltage regulations
  2. Transient recovery
  3. Automatic synchronization
  4. Over current protection
  5. Over temperature protection
  6. Control power failure protection
  7. Short circuit power protection
  8. Variable switching Frequency
  9. Frequency control through an isolator
  10. Internet to the UPS module logic
  11. Inviting of output voltage harmonic distortion
  12. Inverter overloads protection through MCB’s.
- The inverter should meet the following specifications in addition to other requirements stated herein.

<table>
<thead>
<tr>
<th>Voltage Input</th>
<th>Three Phase UPS/Single phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Voltage Output</td>
<td>415V ±1% AC 3 phase / 250V,</td>
</tr>
<tr>
<td>Nominal Voltage Output</td>
<td>1 phase</td>
</tr>
<tr>
<td>Inverter capacity</td>
<td>As per BOQ</td>
</tr>
<tr>
<td>Voltage Regulation</td>
<td></td>
</tr>
<tr>
<td>A) For 0 to 100% loading</td>
<td>&lt; ±1%</td>
</tr>
<tr>
<td>Feature</td>
<td>Specification</td>
</tr>
<tr>
<td>-----------------------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>B) Inverter DC input voltage</td>
<td>$\leq 1%$</td>
</tr>
<tr>
<td>C) Environmental conditions</td>
<td>$\leq 1%$</td>
</tr>
<tr>
<td>Transient voltage regulation</td>
<td></td>
</tr>
<tr>
<td>A) At 100% step load change</td>
<td>$\leq 3%$</td>
</tr>
<tr>
<td>B) At loss or return of AC input</td>
<td>$\leq 3%$</td>
</tr>
<tr>
<td>C) At load transfer from Bypass to Inverter</td>
<td>$\leq 3%$</td>
</tr>
<tr>
<td>Time to recover from transient normal voltage</td>
<td>$&lt; 10$ milli seconds</td>
</tr>
<tr>
<td>Wave Form</td>
<td>Purely Sinusoidal</td>
</tr>
<tr>
<td>A) Normal frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>B) Frequency regulation for all conditions of input supplies, loads and temperature occurring simultaneously or in any combination (automatically controlled)</td>
<td>$\pm 0.01%$</td>
</tr>
<tr>
<td>C) Synchronisation limits for synchronism between the inverter and standby AC source</td>
<td>49 Hz to 51 Hz</td>
</tr>
<tr>
<td>D) Field adjustment range for above</td>
<td>50 $\pm 0.25$ Hz to 50 $\pm 1.5$ Hz</td>
</tr>
<tr>
<td>Total voltage harmonic distortion</td>
<td>$&lt;2%$ THD for 100% linear load</td>
</tr>
<tr>
<td>Specification</td>
<td>Details</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td>----------------------------------------------</td>
</tr>
<tr>
<td>&lt;4% THD for 100% non-linear load</td>
<td></td>
</tr>
<tr>
<td>Phase voltage displacement</td>
<td>120° for balanced load</td>
</tr>
<tr>
<td></td>
<td>120° 2° for unbalanced load</td>
</tr>
<tr>
<td>Duty</td>
<td>Continuous</td>
</tr>
<tr>
<td>Cooling</td>
<td>Forced cooling using fans.</td>
</tr>
<tr>
<td>Ambient temperature operating</td>
<td>-5 to 40°C maximum continuous range</td>
</tr>
<tr>
<td>Operating Relative Humidity</td>
<td>0-95% non-condensing</td>
</tr>
<tr>
<td>Operating altitude</td>
<td>Sea level to 1,000 meters</td>
</tr>
<tr>
<td>Crest Factor</td>
<td>3.5 : 1</td>
</tr>
<tr>
<td>Overload</td>
<td>165% for 1 min.</td>
</tr>
<tr>
<td></td>
<td>125% for 10 min.</td>
</tr>
<tr>
<td>THD at 100% Non Linear Load</td>
<td>&lt; 3%</td>
</tr>
<tr>
<td>At 100% Linear Load</td>
<td>&lt; 2%</td>
</tr>
<tr>
<td>Efficiency AC/AC</td>
<td></td>
</tr>
<tr>
<td>At 100% Load</td>
<td>0.945</td>
</tr>
<tr>
<td>At 75% Load</td>
<td>0.95</td>
</tr>
<tr>
<td>At 50% Load</td>
<td>0.95</td>
</tr>
<tr>
<td>At 25% Load</td>
<td>0.92</td>
</tr>
<tr>
<td>Protection Against</td>
<td>Overload</td>
</tr>
<tr>
<td></td>
<td>Short Circuit</td>
</tr>
<tr>
<td></td>
<td>Input &amp; Output Over voltage</td>
</tr>
<tr>
<td></td>
<td>Battery over Charging</td>
</tr>
<tr>
<td></td>
<td>Battery Over Discharging</td>
</tr>
<tr>
<td>Manual Bypass</td>
<td>Standard &amp; Inbuilt with UPS system</td>
</tr>
</tbody>
</table>
## Proposed Exterior Restoration and Interior Upgradation Works for Bombay Natural History Society Fort, Mumbai Fort, Mumbai

### Abha Narain Lambah Associates
Conservation Architects & Historic Building Consultants

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Static Bypass</strong></td>
<td>Standard &amp; Inbuilt with UPS system</td>
</tr>
<tr>
<td><strong>Noise Level</strong></td>
<td>&lt; 65 dbA</td>
</tr>
<tr>
<td><strong>MTBF</strong></td>
<td>200000 hrs/unit</td>
</tr>
<tr>
<td><strong>MTTR</strong></td>
<td>1000000 hrs for Parallel</td>
</tr>
<tr>
<td><strong>Remote Operation</strong></td>
<td>Output Signals:</td>
</tr>
<tr>
<td></td>
<td>Overload</td>
</tr>
<tr>
<td></td>
<td>Inverter Function Fault</td>
</tr>
<tr>
<td></td>
<td>Rectifier Charger ON</td>
</tr>
<tr>
<td></td>
<td>Rectifier Charger Fault</td>
</tr>
<tr>
<td></td>
<td>Transfer to By Pass Inhibited</td>
</tr>
<tr>
<td></td>
<td>Transfer to inverter function fault</td>
</tr>
<tr>
<td><strong>Input Signals:</strong></td>
<td>Transfer to By Pass Inhibited</td>
</tr>
<tr>
<td></td>
<td>Transfer with load interruption to By Pass Inhibited</td>
</tr>
<tr>
<td></td>
<td>Battery recharge current limiting</td>
</tr>
<tr>
<td></td>
<td>Gradual rectifier charger shutdown</td>
</tr>
<tr>
<td></td>
<td>Rectifier charger current limiting on generator power</td>
</tr>
<tr>
<td></td>
<td>Remote Inverter ON order</td>
</tr>
<tr>
<td></td>
<td>Remote Inverter OFF order</td>
</tr>
<tr>
<td><strong>Mimic Bus Displaying</strong></td>
<td>Emergency power Off.</td>
</tr>
</tbody>
</table>

The UPS front panel shall provide all the displays namely converter status, battery operation, converter on/off, inverter on/off, inverter synchronised with bypass, load on inverter, load on bypass, equalise charge on.

The control panel shall have the following status lights indicating the main system status:

- Emergency shutdown
- Rectifier charger ON
- Rectifier Charger Fault
- Mains supply outside tolerances
- Battery room ventilation Fault
- Battery room temperature outside tolerances
- Battery charging
- Inverter Fault
- Battery Discharged
- Desynchronisation with bypass
- Transfer function fault
<table>
<thead>
<tr>
<th>Overload</th>
<th>Bypass outside tolerances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance configuration</td>
<td></td>
</tr>
</tbody>
</table>

| Microprocessor Interface/        | The UPS microprocessor logic shall provide menu driven operator instructions/alarms through the LCD display on the front panel |
| Diagnostics                      | In addition to Inverter start & stop, transfer of load to static bypass, equalise charge to system battery the following shall also be provided |

| Microprocessor Controlled        | Clear fault log |
| Operator Guidance                | Buzzer reset    |
|                                 | Also following Keys/buttons |
|                                 | Start a battery charge cycle |
|                                 | Start a battery charge cycle return to float charge |
|                                 | A security button to enable following |
|                                 | Inverter synchronisation or desynchronisation with bypass |
|                                 | Forced transfer to inverter with load interruption |
|                                 | Forced transfer to bypass with load interruption |

<table>
<thead>
<tr>
<th>Microprocessor metering controlled</th>
<th>The monitor display shall include a LCD screen without backlighting with 2x20 character lines. The following metering is required to be displayed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage Ph-Ph</td>
<td></td>
</tr>
<tr>
<td>Input current per phase</td>
<td></td>
</tr>
<tr>
<td>Bypass input voltage Ph to Ph &amp; Ph-n</td>
<td></td>
</tr>
<tr>
<td>Bypass input frequency</td>
<td></td>
</tr>
<tr>
<td>Inverter output voltage Ph-Ph &amp; Ph to n</td>
<td></td>
</tr>
<tr>
<td>Inverter output current per phase</td>
<td></td>
</tr>
<tr>
<td>Input output &amp; bypass frequencies</td>
<td></td>
</tr>
<tr>
<td>Percentage load at the inverter output</td>
<td></td>
</tr>
<tr>
<td>Inverter output power factor</td>
<td></td>
</tr>
<tr>
<td>Inverter output in KVA &amp; KW</td>
<td></td>
</tr>
<tr>
<td>DC Voltage</td>
<td></td>
</tr>
<tr>
<td>Load crest Factor</td>
<td></td>
</tr>
<tr>
<td>Battery current (Charge/Discharge)</td>
<td></td>
</tr>
<tr>
<td>Batter backup time</td>
<td></td>
</tr>
<tr>
<td>Microprocessor Diagnostics</td>
<td>The front panel LCD display shall be fully microprocessor controlled &amp; all the features which are indicated with the lights on mimic bus display shall also be displayed on LCD in 2x20 character lines.</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Battery Monitoring</td>
<td>The UPS shall be equipped with the Battery Monitor system providing the following features.</td>
</tr>
<tr>
<td></td>
<td>Measurements of charge &amp; discharge currents.</td>
</tr>
<tr>
<td></td>
<td>Protection against excessive discharge.</td>
</tr>
<tr>
<td></td>
<td>Battery aging calculation.</td>
</tr>
<tr>
<td></td>
<td>Calculation of actual battery backup time.</td>
</tr>
<tr>
<td>Communication</td>
<td>The UPS shall have the factory installed SNMP connectivity &amp; shall be compatible with almost all platforms available as of today in the market for communications.</td>
</tr>
<tr>
<td>Input Ports</td>
<td>The UPS shall have the following input ports</td>
</tr>
<tr>
<td></td>
<td>Power Demand</td>
</tr>
<tr>
<td></td>
<td>Battery Liquid level LOW</td>
</tr>
<tr>
<td></td>
<td>(Not Applicable for SMF)</td>
</tr>
<tr>
<td></td>
<td>Room temperature abnormal</td>
</tr>
<tr>
<td></td>
<td>Remote start</td>
</tr>
<tr>
<td></td>
<td>Remote stop</td>
</tr>
<tr>
<td></td>
<td>Remote equalise charge</td>
</tr>
<tr>
<td></td>
<td>Battery temperature abnormal</td>
</tr>
<tr>
<td></td>
<td>Alarm reset: on UPS front Panel</td>
</tr>
<tr>
<td></td>
<td>Asynchronous command</td>
</tr>
</tbody>
</table>
| Efficiency of Input Isolation Transformer | 95 %.
BYPASS & STATIC TRANSFORMER SWITCH

- Bypass circuit is provided as an alternate source of power other than the inverter. A high speed switch and wrap around contactor should be used to assume the critical load during automatic transfers to the bypass circuit. The static switch & wrap around contactor drives power from an upstream bypass feed circuit breaker internal to the UPS module provided for overload protection. The wrap around contactor should be electrically connected in parallel to static switch and should be at the same time as a static switch energised and upon closure, maintains the by pass source. The bypass circuit should be capable of supplying the UPS rated load current and also provide fault clearing current. UPS system logic should employ sensing which causes the static switch to energise within 150 microseconds thus providing an uninterrupted transfer to the bypass source when any of the following limitations are exceeded.

1. Inverter output under voltage or over voltage
2. Overload beyond the capability of the inverter
3. DC circuit under voltage or over voltage
4. Final End voltage of system battery is reached
5. (Bypass source present and available)
6. System failure (e.g. Logic fail, fuse blown, etc.)
7. The static switch should also confirm to the following minimum requirements.
8. Capacity continuous equal to 100% of continuous rating of the inverter.
9. Capacity overload equivalent to overload characteristics specified for UPS.
10. Nominal bypass input voltage : 415V/240V, 3 phase/1 phase
11. Voltage range : ± 10% nominal
12. Nominal frequency : 50 Hz
13. Frequency range : ± 2%
14. Current : 1000%
15. Duration : 20 milli seconds
16. Ambient operating temperature : 0 to 40 degree C. continuous
17. Operating Relative Humidity : 0-95% non-condensing
18. Operating altitude : Sea level to, 1000 meters
19. Cooling : Natural convection
20. Duty : Continuous

- Automatic Retransfer: In the event, if the critical load has to be transferred to the bypass source due to an overload, the UPS system logic monitors the overload conditions and upon the overload being cleared, automatic retransfer back to the inverter output should be possible.

- Manual transfer: UPS should be capable of transferring the critical load to/from the bypass source via LCD touch panel. When performing manual transfers to inverters or automatic retransfers, the UPS system logic should force the inverter output voltage to match the bypass input voltage and then parallel the inverter & bypass source providing a make before break transition allowing a controlled load current to inverter.

- Maintenance Bypass switch: UPS should include a maintenance bypass switch to enable maintenance inside the UPS.
BATTERY SYSTEM

- The battery system should be provided for the specified minutes back up time to the inverter when the UPS is supplying 100% rated load.
- In case the grid power fails, the inverter derives its input from the battery system thus providing uninterrupted power to the critical load. The transition should be achieved without any switching and with no interruption of power to the critical load.
- On restoration of grid power, the converter should automatically reactivate and provide DC power to the inverter, simultaneously recharging the system battery.
- The batteries should be specially developed for UPS application with the specified discharge rate and should be of sealed maintenance free dry type.
SPECIFICATIONS FOR HVAC WORKS

1. VARIABLE REFRIGERANT VOLUME SYSTEM

1.1 SCOPE

The scope of this section comprises the supply, erection testing and commissioning of Variable Refrigerant Volume System conforming to these specifications and in accordance with the requirements of Drawing and Schedule of Quantities.

1.2 TYPE

Units shall be air cooled, variable refrigerant volume air conditioner consisting of one outdoor unit and multiple indoor units. Each indoor units having capability to cool or heat independently for the requirement of the rooms.

It shall be possible to connect minimum 10 indoor units on one refrigerant circuit. The indoor units on any circuit can be of different type and also controlled individually. Following type of indoor units shall be connected to the system:

- Ceiling mounted Ductable type
- Ceiling suspended type
- Wall mounted type
- Floor mounted TFA

Compressor installed in outdoor unit shall be equipped with inverter controller, and capable of changing the rotating speed to follow variations in cooling and heating load.

Outdoor unit shall be suitable for mix match connection of all type of indoor units.

The refrigerant piping between indoor units and outdoor unit shall be extended up to 150m with maximum 50m level difference without any oil traps.

Both indoor units and outdoor unit shall be factory assembled, tested and filled with first charge of refrigerant before delivering at site.

1.3 OUTDOOR UNIT

The outdoor unit shall be factory assembled, weather proof casing, constructed from heavy gauge mild steel panels and coated with baked enamel finish. The unit should be completely factory wired, tested with all necessary controls and switch gears:

- All outdoor units above 5 HP shall have minimum two scroll compressors and be able to operate even in case one of compressor is out of order.
- In case of outdoor units with multiple compressors, the operation shall not be disrupted with failure of any compressor.
- It should also be provided with duty cycling for switching starting sequence of multiple outdoor units.
The noise level shall not be more than 60 dB(A) at normal operation measured horizontally 1m away and 1.5m above ground level.

The outdoor unit shall be modular in design and should be allowed for side by side installation.

The unit shall be provided with its own microprocessor control panel.

The outdoor unit should be fitted with low noise, aero spiral design fan with large airflow and should be designed to operate compressor linking technology. The unit should also be capable to deliver 55 Pa external static pressure to meet long exhaust duct connection requirement.

1.4 **COMPRESSOR**

The compressor shall be highly efficient scroll type and capable of inverter control. It shall change the speed in accordance to the variation in cooling or heating load requirement:

- The inverter shall be IGBT type for efficient and quiet operation.
- All outdoor units shall have at least 10 steps of capacity control to meet load fluctuation and indoor unit individual control. All parts of compressor shall be sufficiently lubricated stock. Forced lubrication may also be employed.
- Oil heater shall be provided in the compressor casing.

1.5 **HEAT EXCHANGER**

The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminum fins to form a cross fin coil.

- The aluminum fins shall be covered by anti-corrosion resin film.

1.6 **REFRIGERANT CIRCUIT**

The refrigerant circuit shall include liquid & gas shut-off valves and a solenoid valves at condenser end.

1.7 **SAFETY DEVICES**

All necessary safety devices shall be provided to ensure safe operation of the system.

Following safety devices shall be part of outdoor unit; high pressure switch, fuse, crankcase heater, fusible plug, over load relay, protection for inverter, and short recycling guard timer.

1.8 **OIL RECOVERY SYSTEM**

Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigeration piping lengths.
1.9 INDOOR UNIT

This section deals with supply, installation, testing, commissioning of various type of indoor units confirming to general specification and suitable for the duty selected. The type, capacity and size of indoor units shall be as specified in detailed Bill Of Quantities.

1.10 GENERAL

Indoor units shall be either ceiling mounted cassette type, or ceiling mounted ductable type or floor standing type or wall mounted type or other as specified in BOQ. These units shall have electronic control valve to control refrigerant flow rate respond to lead variations of the room.

a. The address of the indoor unit shall be set automatically in case of individual and group control.

b. In case of centralized control, it shall be set by liquid crystal remote controller.

The fan shall be dual suction, aerodynamically designed turbo, multi blade type, statically & dynamically balanced to ensure low noise and vibration free operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having supported from housing. The cooling coil shall be made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/ mechanically expanded for minimum thermal contact resistance with fins. Each coils shall be factory tested at 21kg/sqm air pressure under water.
Unit shall have cleanable type filter fixed to an integrally moulded plastic frame. The filter shall be slide away type and neatly inserted.

Each indoor unit shall have computerized PID control for maintaining design room temperature. Each unit shall be provided with microprocessor thermostat for cooling and heating.

Each unit shall be with wired LCD type remote controller. The remote controller shall memorize the latest malfunction code for easy maintenance. The controller shall have self-diagnostic features for easy and quick maintenance and service. The controller shall be able to change fan speed and angle of swing flat individually as per requirement.

1.10.1 Ceiling Mounted Ductable Type Indoor Unit

Unit shall be suitable for ceiling mounted type. The unit shall include pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel. The unit shall have high static fan for Ductable arrangement.

1.10.2 Ceiling Suspended Indoor Type

Unit shall be suitable for ceiling suspended arrangement below false ceiling. The unit include pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.

1.10.3 High Wall Mounted Indoor Units

The units shall be wall-mounted type. The unit includes pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.

Unit shall have an attractive external casing for supply and return air.

1.10.4 Centralized Type Remote Controller

A multifunctional compact centralized touch screen type controller shall be provided with the system.

The Graphic Controller must act as an advanced air-conditioning management system to give complete control of VRV air-conditioning Equipment. It should have ease of use for the user through its touch screen, icon display and color LCD display.

It shall be able to control up to 64 groups of indoor units with the following functions:

a) Starting/stopping of Airconditioners as a zone or group or individual unit.

b) Temperature setting for each indoor unit or zone.

c) Switching between temperature control modes, switching of fan speed and direction of airflow, enabling/disabling of individual remote controller operation.

d) Monitoring of operation status such as operation mode & temperature setting of individual indoor units, maintenance information, trouble shooting information.
e) Display of air conditioner operation history.

f) Daily management automation through yearly schedule function with possibility of various schedules.

The controller shall have wide screen user friendly color LCD display and can be wired by a non polar 2 wire transmission cable to a distance of 1 km. away from indoor unit.

2. FANS

2.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of centrifugal, in-line and propeller type fans and roof mounted units conforming to these Specifications and in accordance with the requirement of Drawings and Schedule of Quantities.

2.2 TYPE

Propeller fans shall be of the type as indicated on Drawings and identified in Schedule of Quantities.

2.3 CAPACITY

The air-moving capacity of fans shall be as shown on Drawings and in Schedule of Quantities.

2.4 PROPELLER FAN

Propeller fan shall be direct-driven, three or four blade type, mounted on a steel mounting plate with orifice ring.

a. Mounting Plate shall be of steel construction, square with streamlined venturi inlet (reversed for supply applications) coated with baked enamel paint. Mounting plate shall be of standard size, constructed of 12 to 16 gauge sheet steel depending upon the fan size. Orifice ring shall be correctly formed by spinning or stamping to provide easy passage of air without turbulence and to direct the air stream.

b. Fan Blades shall be constructed of aluminium or steel. Fan hub shall be of heavy welded steel construction with blades bolted to the hub. Fan blades and hub assembly shall be statically and dynamically balanced at the manufacturer’s works.

c. Shaft shall be of steel, accurately ground and shall be of ample size for the load transmitted and shall not pass through first critical speed thru the full range of specified fan speeds.

d. Motor shall be standard (easily replaceable) permanent split capacitor or shaded pole for small sizes, totally enclosed with prelubricated sleeve or ball bearings, designed for quiet operation with a maximum speed of 1000 rpm for fans 60 cm dia or larger and 1440 rpm for fans 45 cm dia and smaller. Motors for larger fans shall be...
suitable for 415±6% volts, 50 cycles 3 phase power supply, and for smaller fans shall be suitable for 220 ± 6% volts, 50 cycles single phase power supply. Motors shall be suitable for either horizontal or vertical service as indicated on Drawings and in Schedule of Quantities.

e. Accessories : The following accessories shall be provided with propeller fans:

i. Wire guard on inlet side and birdscreen at the outlet.

ii. Fixed or gravity louvers built into a steel frame at the outlet.

iii. Regulator for controlling fan speed for single phase fan motor.

iv. Single phase preventors for 3 phase fans.

2.5 CEILING INLINE FAN

All toilets & other areas having limited space behind false ceiling shall be provided with Ceiling Mounted Inline Fans

The Fan casing shall be made of Galvanized Steel & shall have decorative front panel made of ABS Plastic & fitted with Air Filter. The Front Panel shall be openable type to provide easy access to Air Filter without use of any tools. The Fan shall be equipped with GSS Backdraft Damper to prevent back air flow. The Damper blade should open with air pressure & shall be equipped with a retaining spring.

Fan shall have backward impeller directly driven with single phase IP-44 external rotor motor having class F insulation. The motor shall have in-built thermal overload protection with automatic restart. Fan motor shall be equipped with ball bearing designed for at least 40000 working hours service life. Fan speed should be controllable by voltage/frequency variation. The fan shall be connected to power mains through the external terminal block.

Fan Impeller shall be Statically & Dynamically Balanced.

The Fan assembly shall be fixed to Ceiling with mounting bracket supplied by Fan manufacturer along with Fan assembly.

2.6 CENTRIFUGAL FAN

Centrifugal fan shall be DWDI / SWSI Class I construction arrangement 3 (i.e. bearings on both the sides) for DWDI fans complete with access door, squirrel-cage induction motor, V-belt drive, belt guard and vibration isolators, direction of discharge / rotation, and motor position shall be as per the Approved-for-Construction shop drawings.

a. Housing shall be constructed of 14 gage sheet steel welded construction. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans, however neoprene / asbestos packing should be provided throughout split joints to make it air-tight.
18 gauge galvanized wire mesh inlet guards of 5 cm sieves shall be provided on both inlets. Housing shall be provided with standard cleanout door with handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.

b. Fan Wheel shall be backward-curved non-over loading type. Fan wheel and housing shall be statically and dynamically balanced. For fans upto 450 mm dia, fan outlet velocity shall not exceed 550 meter/minute and maximum fan speed shall not exceed 1450 rpm. For fans above 450 mm dia, the outlet velocity shall be within 700 meter/minute and maximum fan speed shall not exceed 1000 RPM. High static pressure fan speed shall be as per manufacturer.

c. Shaft shall be constructed of steel, turned, ground and polished.

d. Bearings: shall be of the sleeve / ball-bearing type mounted directly on the fan housing. Bearings shall be designed especially for quiet operation and shall be of the self-aligning, oil / grease pack pillow block type.

e. Motor: Fan motor shall be energy efficient and suitable for 415±10% volts, 50 cycles, 3 phase AC power supply, squirrel-cage, totally enclosed, fan-cooled motor, provided with class F insulation, and of approved make. Motor name plate horsepower shall exceed brake horsepower by a minimum of 10%. Motor shall be designed specially for quiet operation and motor speed shall not exceed 1440 rpm. The fan and motor combination selected for the particular required performance shall be of the most efficient (smallest horse power), so that sound level is lowest.

<table>
<thead>
<tr>
<th>HP</th>
<th>POWER FACTOR</th>
<th>EFFICIENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FL</td>
<td>3/4L</td>
</tr>
<tr>
<td>0.50</td>
<td>0.71</td>
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<td>1.50</td>
<td>0.77</td>
<td>0.70</td>
</tr>
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<td>0.70</td>
</tr>
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<td>3.00</td>
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</tr>
<tr>
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<td>0.78</td>
</tr>
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<td>7.50</td>
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<td>0.80</td>
</tr>
<tr>
<td>10.00</td>
<td>0.86</td>
<td>0.83</td>
</tr>
<tr>
<td>12.50</td>
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<td>0.82</td>
</tr>
<tr>
<td>15.00</td>
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<td>0.83</td>
</tr>
<tr>
<td>20.00</td>
<td>0.85</td>
<td>0.83</td>
</tr>
<tr>
<td>25.00</td>
<td>0.85</td>
<td>0.82</td>
</tr>
<tr>
<td>30.00</td>
<td>0.85</td>
<td>0.80</td>
</tr>
<tr>
<td>40.00</td>
<td>0.86</td>
<td>0.85</td>
</tr>
<tr>
<td>50.00</td>
<td>0.87</td>
<td>0.85</td>
</tr>
<tr>
<td>60.00</td>
<td>0.88</td>
<td>0.86</td>
</tr>
<tr>
<td>75.00</td>
<td>0.87</td>
<td>0.85</td>
</tr>
</tbody>
</table>

f. Drive to fan shall be provided through belt with adjustable motor sheave and a standard belt guard. Belts shall be of the oil-resistant type.
2.7 AXIAL FLOW FAN

Fan shall be complete with motor, motor mount, belt driven (or direct driven) and vibration isolation type, suspension arrangement as per approved for construction shop drawings.

a. Casing: shall be constructed of heavy gage sheet steel. Fan casing, motor mount and straightening vane shall be of welded steel construction. Motor mounting plate shall be minimum 15 mm thick and machined to receive motor flange.

An inspection door with handle and neoprene gasket shall be provided. Casing shall have flanged connection on both ends for ducted applications. Support brackets for ceiling suspension shall be welded to the casing, for connection to hanger bolts. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be bonderized, primed and finish coated with enamel paint.

b. Rotor: hub and blades shall be cast aluminium or cast steel construction. Blades shall be die-formed aerofoil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. Fan blades mounting on the hub shall be statically and dynamically balanced. Extended grease leads for external lubrication shall be provided. The fan pitch control may be manually readjusted at site upon installation, for obtaining actual air flow values, as specified and quoted.

c. Motor: shall be energy efficient squirrel-cage, totally-enclosed, fan cooled, standard frame, constant speed, continuous duty, single winding, suitable for 415±10% volts, 50 cycles, 3 phase AC power supply, provided with class "F" insulation. Motor shall be specially designed for quiet operation. The speed of the fans shall not exceed 1000 RPM for fans with impeller diameter above 450 mm, and 1440 RPM for fans with impeller diameter 450 mm and less. For lowest sound level, fan shall be selected for maximum efficiency or minimum horsepower. Motor conduit box shall be mounted on exterior of fan casing, and lead wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible metal conduit.

<table>
<thead>
<tr>
<th>HP</th>
<th>POWER FACTOR</th>
<th>EFFICIENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.50</td>
<td>0.71 0.62 0.50</td>
<td>73.00 73.00 68.00</td>
</tr>
<tr>
<td>0.75</td>
<td>0.74 0.64 0.50</td>
<td>78.00 78.00 70.00</td>
</tr>
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<td>1.00</td>
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<td>83.80 83.80 80.00</td>
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<tr>
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<td>0.77 0.70 0.57</td>
<td>85.00 85.00 81.00</td>
</tr>
<tr>
<td>3.00</td>
<td>0.82 0.74 0.60</td>
<td>86.40 86.40 84.00</td>
</tr>
<tr>
<td>5.00</td>
<td>0.82 0.78 0.63</td>
<td>88.30 88.30 86.00</td>
</tr>
<tr>
<td>7.50</td>
<td>0.85 0.80 0.71</td>
<td>89.50 88.50 88.00</td>
</tr>
</tbody>
</table>
d. Drive:  To fan shall be provided through belt drive with adjustable motor sheave and standard sheet steel belt guard with vented front for heat dissipation. Belts shall be of oil-resistant type.

e. Vibration Isolation:  The assembly of fan and motor shall be suspended from the slab by vibration isolation suspension of heavy duty spring isolators type.

f. Accessories:  The following accessories shall be provided with all fans:

i. Outlet cone for static pressure regain.

ii. Inlet cone.

Fan silencers may be provided where specifically called for in Schedule of Quantities. Fans shall be factory assembled and shipped with all accessories factory-mounted.

**Axial Flow Fan shall be AMCA certified for Air and Sound performance in accordance to AMCA 210 and AMCA 300**

### 2.8 PERFORMANCE DATA

All fans shall be selected for the lowest operating noise level. Capacity ratings, power consumption, with operating points clearly indicated, shall be submitted and verified at the time of testing and commissioning of the installation.

### 2.9 TESTING

Capacity of all fans shall be measured by an anemometer. Measured air flow capacities shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.
3. **PIPING**

3.1 **SCOPE**

The scope of this section comprises the supply and laying of pipes, pipe fittings and valves, testing and balancing of all condensate and refrigerant piping required for the complete installation as shown on the Drawings. All piping inclusive of fittings and valves shall follow the applicable Indian Standards.

3.2 **PIPE SIZES**

Pipe sizes shall be as required for the individual fluid flows. Various pipe sizes have been indicated on the Drawings, these are for Contractor’s guidance only and shall not relieve contractor of responsibility for providing smooth noiseless balanced circulation of fluids.

3.3 **DRAIN PIPING**

a. The piping system shall consist of Non-pressure pipe up to 6 kg/ sq.mm UPVC piping from 15 mm to 50 mm.

b. For any internal works, the UPVC pipes and fittings shall be embedded in the wall chase or run on the floor/ceiling unless otherwise specified. No unsightly exposed runs shall be permitted.

c. For proper drainage of Condensate, ‘U’ trap shall be provided in the drain piping.

d. All condensate drain piping shall be insulated as per the section “Insulation” as indicated in Schedule of Quantities.

3.4 **REFRIGERANT PIPING**

a. All refrigerant pipes and fittings shall be hard drawn copper tubes and wrought copper / brass fittings suitable for connection with silver solder / phos-copper.

b. All joints in copper piping shall be sweat joints using low temperature brazing and / or silver solder. Before joining any copper pipe or fittings, its interiors shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently, it shall be thoroughly blown out using carbon dioxide / nitrogen.

c. Refrigerant lines shall be sized to limit pressure drop between the evaporator and condensing unit to less than 0.2 kg per sq.cm.

d. Sight glass with moisture indicator and removable type combination dryer cum filter with MS housing and brass wire mesh / punched brass sheet shall be installed in liquid line of the refrigeration system incorporating a three valve by pass. After ninety days of operation, liquid line drier cartridges shall be replaced.
e. Heat exchanger shall be MS heavy duty pipe in pipe type and without any joint in the inner pipe.

f. Horizontal suction line shall be pitched towards the compressor and no reducers shall be provided for proper oil return.

g. After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using Freon mixed with nitrogen / carbon dioxide at a pressure of 20 kg per sq. cm (high side) and 10 kg per sq. cm (low side). Pressure shall be maintained in the system for a minimum of 12 hours. The system shall then be evacuated to a minimum vacuum of 70 cm of mercury and held for 24 hours. Vacuum shall be checked with a vacuum gage. All refrigeration piping shall be installed strictly as per the instructions and recommendations of air conditioning equipment manufacturer.

4. AIR PURIFICATION/ FILTRATION SYSTEM

A. ESP Filter:

This filter section of the specification covers the supply of Micro Electrostatic Technology (ESP Filter) with Ultra High One – time purification efficiency and substantial reduction in the pollutants inside the premises: The technology is based on a simple phenomenon of charging the particles and collecting the same in the collector area. The system is effective for re circulated space to filter out the particulate matter, the efficiency of the system is 90 percent per pass for PM 2.5 micron sized particles. The Initial Pressure Drop (IPD) of 5 mm which gets added to the system. The system has significant advantages such as having a Filtration efficiency of MERV 13/14 at 5 mm IPD, washable filters, life of at least 5-7 years or greater if maintained properly. The system functionality along with the filtration efficiency details is enclosed for reference.

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>Particulars</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Micro – Electrostatic Unit</td>
<td>Ductable Indoor Unit</td>
</tr>
<tr>
<td>2</td>
<td>Input Power</td>
<td>220 – 240V</td>
</tr>
<tr>
<td>3</td>
<td>Pressure Drop</td>
<td>&lt;50 Pa @ 2.5m/s</td>
</tr>
<tr>
<td>4</td>
<td>Efficiency (PM2.5)</td>
<td>&gt;90% @ 2.5m/s</td>
</tr>
<tr>
<td>5</td>
<td>Status Indication</td>
<td>Running and Cleaning</td>
</tr>
<tr>
<td>6</td>
<td>Components</td>
<td>Micro Static Filter and Particulate Filter</td>
</tr>
<tr>
<td>7</td>
<td>Net Weight (kg)</td>
<td>5kg to 12kg</td>
</tr>
</tbody>
</table>
5. **AIR DISTRIBUTION**

5.1 **SCOPE**

The scope of this section comprises supply fabrication, installation and testing of all sheet metal / aluminum ducts, supply, installation, testing and balancing of all grilles, registers and diffusers. All to be in accordance with these specifications and the general arrangement shown on the Drawings.

5.2 **DUCT MATERIALS**

5.2.1 **Raw Materials**

Galvanizing shall be Class VIII – light coating of zinc, nominal 120gm/sq.m surface area and Lock Forming Quality prime material along with mill test certificates. In addition, if deemed necessary, samples of raw material, selected at random by owner’s site representative shall be subject to approval and tested for thickness and zinc coating at contractor’s expense.

5.2.2 **Gauges, Bracing By Size Of Ducts**

All ducts shall be fabricated from galvanized steel / aluminum of the following thickness, as indicated as below:

<table>
<thead>
<tr>
<th>Rectangular Ducts G. S.</th>
<th>Pressure 250 Pa</th>
<th>Duct Section Length 1.2 m (4 ft)</th>
<th>Bracing Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–500 mm</td>
<td>26</td>
<td>C&amp;S Connector</td>
<td>Nil</td>
</tr>
<tr>
<td>501 – 750 mm</td>
<td>26</td>
<td>C&amp;S Connector</td>
<td>Nil</td>
</tr>
<tr>
<td>751 – 900 mm</td>
<td>26</td>
<td>TDF Flange</td>
<td>Nil</td>
</tr>
<tr>
<td>901 – 1200 mm</td>
<td>24</td>
<td>TDF Flange</td>
<td>Nil</td>
</tr>
<tr>
<td>1201 – 1500 mm</td>
<td>22</td>
<td>TDF Flange</td>
<td>Nil</td>
</tr>
<tr>
<td>1501 – 1800 mm</td>
<td>22</td>
<td>TDF Flange</td>
<td>JTR or ZEE BAR</td>
</tr>
<tr>
<td>1801 – 2100 mm</td>
<td>20</td>
<td>TDF Flange</td>
<td>JTR or ZEE BAR</td>
</tr>
<tr>
<td>2101 – above</td>
<td>18</td>
<td>TDF Flange</td>
<td>JTR or ZEE BAR</td>
</tr>
</tbody>
</table>

5.3 **FABRICATION STANDARDS & EQUIPMENT**

All duct construction and installation shall be in accordance with SMACNA standards. In addition ducts shall be factory fabricated utilizing the following machines to provide the requisite quality of ducts.

a. Coil (Sheet metal in Roll Form) lines to facilitate location of longitudinal seams at corners/folded edges only, for required duct rigidity and leakage free characteristics. No longitudinal seams permitted along any face side of the duct.
b.  All ducts, transformation pieces and fittings to be made on CNC profile cutter for requisite accuracy of dimensions, location and dimensions of notches at the folding lines.

c.  All edges to be machine treated using lock formers, flangers and rollers for turning up edges.

d.  Kitchen exhaust ducting shall be with 16 G MS. Suitable access doors shall be provided at every 3m. Provision shall be made for firefighting agency to install duct mounted sprinklers at every 3m. Generally exhaust ducts shall have slope towards kitchen hood.

5.4 DUCT CONSTRUCTION

5.4.1 All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA codes.

a.  Ducts so identified on the Drawings shall be acoustically lined and insulated from outside as described in the section “Insulation” and as indicated in schedule of Quantities. Duct dimensions shown on drawings, are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in Schedule of quantities. The fabricated duct dimensions should be as per approved drawings and care should be taken to ensure that all connecting sections are dimensionally matched to avoid any gaps.

b.  Ducts shall be straight and smooth on the inside with longitudinal seams shall be airtight and at corners only which shall be either Pittsburgh or snap button as per SMACNA practice, to ensure air tightness.

c.  All ducts up to 75cms width within conditioned spaces shall have slip and drive (C & S/SS) joints. The internal ends of slip joints shall be in the direction of airflow. Care should be taken to ensure that S/SS Cleats are mounted on the longer side of the duct and Cleats on the shorter side. Ducts and accessories within ceiling spaces, visible from air-conditioned areas shall be provided with two coats of mat black finish paint.

d.  Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Air-turns (vanes) shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.

e.  Ducts shall be fabricated as per details shown on Drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.

f.  All sheet metal connection, partitions and plenums, required to confine the flow of air to and through the filters and fans, shall be constructed of 18 gauge GSS / 16gauge aluminum, thoroughly stiffened with 25mm x 25mm x 3mm galvanized steel angle braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Access doors shall be not less than 45cm x 45cm in size.
PROPOSED EXTERIOR RESTORATION AND INTERIOR UPGRADATION WORKS FOR BOMBAY NATURAL HISTORY SOCIETY FORT, MUMBAI FORT, MUMBAI

Abha Narain Lambah Associates
Conservation Architects & Historic Building Consultants

5.5 DAMPERS

a. Dampers: All duct dampers shall be opposed blade louver dampers of robust 16 G GSS construction and tight fitting. The design, method of handling and control shall be suitable for the location and service required.

b. Dampers shall be provided with suitable links levers and quadrants as required for their proper operation. Control or setting device shall be made robust, easily operable and accessible through suitable access door in the duct. Every damper shall have an indicating device clearly showing the damper position at all times.

c. Dampers shall be placed in ducts at every branch supply or return air duct connection, whether or not indicated on the Drawings, for the proper volume control and balancing of the air distribution system.

5.6 SUPPLY AND RETURN AIR REGISTERS

Supply & return air registers shall be of either steel or aluminium sections as specified in schedule of quantities. Steel construction registers shall have primer Coat finish whereas extruded aluminium registers shall be either Anodised or Powder Coated as specified in Schedule of Quantities. These registers shall have individually adjustable louvers both horizontal and vertical. Supply air registers shall be provided with key operated opposed blade extruded aluminium volume control damper anodised in matt black shade.

The registers shall be suitable for fixing arrangement having concealed screws as approved by Architect. Linear continuous supply cum return air register shall be extruded aluminium construction with fixed horizontal bars at 15 Deg. inclination & flange on both sides only (none on top & bottom). The thickness of the fixed bar louvers shall be minimum 5.5 mm in front and 3.8 mm in rear with rounded edges. Flanges on the two sides shall be 20 mm/30 mm wide as approved by Architect. The grilles shall be suitable for concealed fixing. Volume control dampers of extruded aluminium anodized in black color shall be provided in supply air duct collars. For fan coil units horizontal fixed bar grilles as described above shall be provided with flanges on four sides, and the core shall be suitable for clip fixing, permitting its removal without disturbing the flanges.

a. All registers shall be selected in consultation with the Architect. Different spaces shall require horizontal or vertical face bars, and different width of margin frames. These shall be procured only after obtaining written approval from Architect for each type of register.
b. All registers shall have a soft continuous rubber/foam gasket between the periphery of the register and the surface on which it has to be mounted. The effective area of the registers for air flow shall not be less than 66 percent of gross face area.

c. Registers specified with individually adjustable bars shall have adjustable pattern as each grille bar shall be pivotable to provide pattern with 0 to +45° horizontal arc and up to 30° deflection downwards. Bars shall hold deflection settings under all conditions of velocity and pressure.

d. Bar longer than 45 cm shall be reinforced by set-back vertical members of approved thickness.

e. All volume control dampers shall be anodised aluminium in mat black shade.

5.7 DOCUMENTATION & MEASUREMENTS FOR DUCTING

All ducts fabricated and installed should be accompanied and supported by proper documentation viz:

a. Bill of material/Packing list for every duct section supplied.

Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge-wise. Each and every duct piece to have a tag number, which should correspond to the serial number, assigned to it in the measurement sheet. The above system will ensure speedy and proper site measurement and verification.

Unless otherwise specified, measurements for ducting for the project shall be on the basis of centerline measurements described herewith.

Ductwork shall be measured on the basis of external surface area of ducts. Duct measurements shall be taken before application of the insulation. The external surface area shall be calculated by measuring the perimeter comprising overall width and depth, including the corner joints, in the center of each duct section, multiplying with the overall length from flange face to flange face of each duct section and adding up areas of all duct sections. Plenums shall also be measured in a similar manner.

For tapered rectangular ducts, the average width and depth shall be considered for perimeter, whereas for tapered circular ducts, the diameter of the section midway between large and small diameter shall be adopted. The length of tapered duct section shall be the centerline distance between the flanges of the duct section.

For special pieces like bends, tees, reducers, branches and collars, mode of measurement shall be identical to that described above using the length along the centerline.

The quoted unit rate for external surface of ducts shall include all wastage allowances, flanges and gaskets for joints, nuts and bolts, hangers and angles with double nuts for supports, rubber strip 5mm thick between duct and support, vibration isolator suspension where specified or required, inspection chamber/access panel, splitter
damper with quadrant and lever for position indication, turning vanes, straightening vanes, and all other accessories required to complete the duct installation as per the specifications. These accessories shall NOT be separately measured nor paid for.

b. Special Items for Air Distribution shall be measured by the cross-section area perpendicular to air flow, as identified herewith:

i. Grilles and registers - width multiplied by height, excluding flanges. Volume control dampers shall form part of the unit rate for registers and shall not be separately accounted.

ii. Diffusers - cross section area for air flow at discharge area, excluding flanges. Volume control dampers shall form part of unit rate for supply air diffusers and shall not be separately accounted.

iii. Linear diffusers - shall be measured by cross-sectional areas and shall exclude flanges for mounting of linear diffusers. The supply air plenum for linear diffusers shall be measured with ducting as described earlier.

iv. Fire dampers - shall be measured by their cross sectional area perpendicular to the direction of air flow. Quoted rates shall include the necessary collars and flanges for mounting, inspection pieces with access door, electrical actuators and panel. No special allowance shall be payable for extension of cross section outside the air stream.

v. Flexible connection - shall be measured by their cross sectional area perpendicular to the direction of air flow. Quoted rates shall include the necessary mounting arrangement, flanges, nuts and bolts and treated-for-fire requisite length of canvas cloth.

5.8 TESTING AND BALANCING

After the installation of the entire air distribution system is completed in all respects, all ducts shall be tested for air leaks by visual inspection.

The entire air distribution system shall be balanced using an anemometer. Measured air quantities at fan discharge and at various outlets shall be identical to or less/excess than 5 percent in excess of those specified and quoted. Branch duct adjustments shall be permanently marked after air balancing is completed so that these can be restored to their correct position if disturbed at any time. Complete air balance report shall be submitted for scrutiny and approval, and four copies of the approved balance report shall be provided with completion documents.
6. **INSULATION**

6.1 **SCOPE**

The scope of this section comprises the supply and application of insulation conforming to these specifications.

6.2 **MATERIAL**

Insulation material for Duct insulation shall be either Closed Cell Elastomeric Nitrile Rubber or closed cell cross linked polyethylene foam or resin bonded fibre glass as specified in Bill of Quantity. The duct insulation shall have self adhesive backing with a peel-off cover for easy installation at site. Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.038 W/m·K or 0.313 Kcal/Mhr·°C or 0.212 BTU/(Hr-ft²·°F/inch) at an average temperature of 30°C. The product shall have temperature range of –40°C to 105°C. Density of material shall not be less than 0.06 gm/cm³. The insulation shall have fire performance such that it passes minimum CLASS 1 as per BS476 part 7 for surface spread of flame. Water vapour permeability shall not exceed 0.024 perm inch (3 x 10⁻¹⁴ Kgs/m.sec.Pa). The material shall have approval from the Chief Fire Officer.

**MATERIAL (XLPE)**

Thermal insulation material for Duct & Pipe insulation shall be closed cell Cross linked polyolefin. Thermal conductivity of the insulation material shall not exceed 0.037 W/m·K at an average temperature of 25°C for ducts. The thermal conductivity of the insulation material shall not exceed 0.034 W/m·K at an average temperature of 0°C for pipes. Density of the Cross linked polyolefin rubber shall be 25-30 Kg/m³. The product shall have temperature range of –40°C to 110°C. The intermittent range shall be –200°C to 150°C. The insulation material in bare form (without any facing) shall be fire rated for Class 0 as per UL 94. The flammability and smoke density shall be 25/50 as per ASTM E 84. Water vapour diffusion resistance factor(μ) ≥ 7000 without any facing material. The water absorption (weight%)shall not exceed 5 as per ASTM D 1056 without any facing material. It should be CFC free. The thermal insulation product needs to be non polar. There should be no unsaturated bond in the fundamental molecule of the material as on full curing. This property is extremely essential as the insulation remains invisible to the human eye and could be exposed to various conditions as water leaks, dirt, gasses, indoor and outdoor air pollutants. Being non polar results in material being stable in such conditions and prevents reduction of the thermal resistance and UIC (under Insulation corrosion). The stability of thermal resistance is key to the energy savings and is the key function of insulation. It should not be corrosive to copper and stainless when tested as per DIN 1988. No cracks should develop when exposed to UV (accelerated weathering resistance test cycle UVB-313 at 60°C/8h, CON at 50°C/4h) as per ASTM G 154-04. The resistance to microbiological growth should be in accordance to UL 181 – and meet the acceptance criteria of resistance to fungal contamination as per ASTM G21 and resistance to bacteria as per ASTM 2180.

Insulation material for Duct Acoustic Lining and duct shall be resin bonded fibre glass. The thermal conductivity shall not exceed 0.034 K Cal/(hr-sq.m-deg C/meter) or 0.23 BTU/(hr.sq.ft.-deg F/inch) at 32 deg C (90 deg F) mean temperature and density shall be not less than 32 Kg / Cum.

Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer test certificate
for thermal conductivity values and density. Samples of insulation material from each lot delivered at site may be selected by Owner’s site representative and gotten tested for thermal conductivity and density at Contractor’s cost. All joints shall be sealed properly with adhesive, which shall provide similar vapour barrier as the original insulating material.

<table>
<thead>
<tr>
<th>Ducting position</th>
<th>Thk. for non-coastal places</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA/RA duct</td>
<td>13mm</td>
</tr>
<tr>
<td>Ducted return air system</td>
<td>SA duct: 19mm</td>
</tr>
<tr>
<td></td>
<td>RA duct: 13mm</td>
</tr>
<tr>
<td>Both SA&amp; RA exposed</td>
<td>Both 25mm</td>
</tr>
</tbody>
</table>

6.3 DUCT ACOUSTIC LINING

Duct acoustic lining material shall be Nitrile Rubber open cell foam. Thermal conductivity of the insulation material shall not exceed 0.047 W/m\(^o\)K at an average temperature of 20\(^o\)C. Density of the nitrile rubber shall be 140 – 180Kg/m\(^3\). The material should withstand maximum surface temperature of +85\(^o\)C and minimum surface temperature of -20\(^o\)C. The material should conform to Class 1 rating for surface spread of Flame in accordance to BS 476 Part 7 & UL 94 (HBF, HF 1 & HF 2) in accordance to UL 94, 1996.

It should have Microban*: antimicrobial product protection, and should pass Fungi Resistance as per ASTM G 21 and Bacterial Resistance as per ASTM E 2180. The insulation should pass Air Erosion Resistance Test in accordance to ASTM Standard C 1071-05 (section 12.7).

Thickness of the material shall be 15 mm thick specified for the individual application. The insulation should be installed as per manufacturer’s recommendation.

* Microban is a registered trademark of the Microban Products Company, USA.

- The Random Incidence Sound Absorption Coefficient (RISAC); tested as per ISO354, should be minimum as per following chart

<table>
<thead>
<tr>
<th>Freq (Hz)</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
<th>NRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mm</td>
<td>0.03</td>
<td>0.04</td>
<td>0.14</td>
<td>0.04</td>
<td>0.88</td>
<td>1.00</td>
<td>0.35</td>
</tr>
<tr>
<td>15 mm</td>
<td>0.01</td>
<td>0.09</td>
<td>0.29</td>
<td>0.74</td>
<td>1.08</td>
<td>0.83</td>
<td>0.55</td>
</tr>
<tr>
<td>20 mm</td>
<td>0.04</td>
<td>0.13</td>
<td>0.40</td>
<td>0.90</td>
<td>1.04</td>
<td>0.90</td>
<td>0.60</td>
</tr>
<tr>
<td>25 mm</td>
<td>0.02</td>
<td>0.25</td>
<td>0.86</td>
<td>1.14</td>
<td>0.88</td>
<td>0.99</td>
<td>0.80</td>
</tr>
<tr>
<td>30 mm</td>
<td>0.07</td>
<td>0.32</td>
<td>0.99</td>
<td>1.16</td>
<td>0.93</td>
<td>1.08</td>
<td>0.85</td>
</tr>
<tr>
<td>50 mm</td>
<td>0.23</td>
<td>0.73</td>
<td>1.29</td>
<td>0.99</td>
<td>1.09</td>
<td>1.11</td>
<td>1.05</td>
</tr>
</tbody>
</table>

Installation Procedure

The inside surface for the ducts shall be covered with adhesive recommended by the manufacturer. Cut Foamed sheets into required sizes apply adhesive on the foam and stick it to the duct surface.

6.4 DUCT INSULATION

Abha Narain Lambah Associates
Conservation Architects & Historic Building Consultants
6.4.1 With Nitrile Rubber or Cross linked polyethylene external thermal insulation shall be provided as follows: The thickness of closed cell shall be as shown on drawing or identified in the schedule of quantity. Following procedure shall be adhered to:

Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work. Measurement of surface dimensions shall be taken properly to cut rubber sheets to size with sufficient allowance in dimension. Material shall be fitted under compression and no stretching of material shall be permitted. Remove the protective backing of self adhesive sheet and press the material sheet on to the metal surface. The insulating material sheet shall be placed in position and pressed firmly to achieve a good bond. All longitudinal and transverse joints shall be sealed as per manufacturer recommendations. The adhesive shall be strictly as recommended by the manufacturer.

6.4.2 With fibre glass external thermal insulation shall be provided as follows:

Duct surfaces shall be cleaned, adhesive shall be applied on all sides and 25 mm thick resin bonded fiberglass insulation panels shall be wrapped before adhesive dries out. All longitudinal and transverse joints shall be sealed by covering with fiberglass tissue paper overlapped by minimum 100 mm to cover all joints. PVC straps at 400 mm centre shall be used to hold insulation in position. Cladding shall be provided with 28 gauge GI sheet cladding.

All longitudinal and transverse joints in outer cladding shall have minimum overlap of 50 mm duly beaded and grooved and shall be sealed with elastomeric metal sealant 95-44 of Benjamin Foster USA or equivalent. Self tapping screws/pop rivets spots shall be sealed with above sealant. The cladding shall be done in a neat & clean manner to give true surface.

6.5 PIPING INSULATION

All refrigerant and condensate drain piping shall be insulated in the manner specified herein. Before applying insulation, all pipe shall be brushed and cleaned. Thermal insulation shall be applied for refrigerant piping as follows or as specified in drawings or schedule of quantity:

<table>
<thead>
<tr>
<th>Pipe size (mm)</th>
<th>Thickness of closed cell insulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 19.1 mm</td>
<td>13 mm.</td>
</tr>
<tr>
<td>Above 19.1 mm</td>
<td>19 mm</td>
</tr>
</tbody>
</table>

Insulating material in tube form shall be sleeved on the pipes. On existing piping, slit opened tube from insulating material shall be placed over the pipe and adhesive shall be applied as suggested by the manufacturer. Adhesive must be allowed to tack dry and then press surface firmly together starting from butt end and working towards centre. Wherever flat sheets shall be used it shall be cut out in correct dimension. All longitudinal and transverse joints shall be sealed as per manufacturer recommendations. The insulation shall be continuous over the entire run of piping, fittings and valves.

For exposed piping, after sufficient curing time, apply manufacturer’s recommended thickness of U/V paint in two coats. This shall be applied sparingly but must cover the entire surface of
insulating material. Allow first coat to dry. Adequate film thickness is essential to ensure weather protection.

All insulation work shall be carried out by skilled workmen specially trained in this kind of work. All insulated pipes shall be labeled (S.R. or R.R.) and provided with 300 mm wide band of paint along circumference at every 1200 mm for colour coding. Direction of fluid shall also be marked.

6.6 PROTECTIVE COATING OVER INSULATION

To provide mechanical strength and protection from damage & UV rays all exposed pipe insulation as indicated in BOQ shall be covered with fibreglass fabric. The fibreglass fabric shall be applied with one coat of epoxy compound. The coat shall be allowed to cure to non stick state. Subsequently second coat of compound shall be applied to give a tough and smooth finish to the insulated surface.

6.7 UNDERDECK INSULATION

Underdeck insulation shall be 50mm thick TF Quality expanded polystyrene (32 Kg/m3) or 30mm thick phenotherm. Underdeck surface of ceiling shall be cleaned and made dirt free. Insulation panels shall be pasted on this surface with black CPRX compound. 28g wire net shall be tightened around insulation so as to avoid any kind of sagging. Ends of net shall be overlapping by at least 25mm. Overlaps shall be screwed with galvanised screws to avoid rusting.

6.8 MEASUREMENT OF INSULATION

Unless otherwise specified measurement pipe insulation for the project shall be on the basis of centerline measurements described herewith

a. Pipe Insulation shall be measured in units of length along the centre line of the installed pipe, strictly on the same basis as the piping measurements described earlier. The linear measurements shall be taken before the application of the insulation. It may be noted that for piping measurement, all valves, orifice plates and strainers are separately measurable by their number and size. It is to be clearly understood that no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.
7. **TREATED FRESH AIR UNITS**

7.1 **SCOPE**

The scope of this section, comprises the supply, erection, testing and commissioning of double skin construction air handling units, conforming to these Specifications and in accordance with requirements of drawings and of the Schedule of Quantities.

7.2 **TYPE**

The air handling units shall be double skin construction, draw-thru type comprising of various sections, filter section, coil section and fan section, mixing box, (wherever the return air and fresh air are ducted) as shown on drawings and included in schedule of quantities.

7.3 **CAPACITY**

The air handling capacities, maximum motor horse power and static pressure shall be as shown on Drawings and in Schedule of Quantities.

7.4 **CASING**

Double skinned panels shall be 23 / 46 mm thick made of galvanized steel, pressure injected with foam insulation (density 40 kg/m$^3$) with K factor not exceeding 0.02 Watt/Mc shall be fixed to 1.5 mm thick aluminium alloy twin box section structural framework with stainless steel screws. Outer sheet of panels shall be made of galvanized preplasticised sheet of 0.63 mm thick, and inner sheet of 24 Gauge plain G.I. Sheet.

The entire framework shall be mounted on an aluminium alloy or galvanized steel (depending on size) channel base as per manufacturer's recommendation. The panels shall be sealed to the framework by heavy duty gaskets held captive in the framed extrusion. All panels shall be detachable or hinged. Hinges shall be made of die cast aluminum / hard nylon with stainless steel pivots, handles shall be made of hard nylon and be operational from both inside and outside of the unit. Units supplied with various sections shall be suitable for on site assembly with continuous foam gasket. All fixing and gaskets shall be concealed.

Units shall have hinged, quick opening access door in the fan section and also in filter section where filters are not accessible from outside. Access doors shall be double skin type.

Condensate drain pan shall be fabricated from 18 gage stainless steel sheet with all corners welded. It shall be isolated from bottom floor panel with 19 mm elastomeric nitrile rubber.

Internal panels shall be fabricated so that there are no gaps between the panel and framework. Fabrication clearances shall be closed with blank-off pieces or with sealant. Partitions shall be of sufficient thickness to prevent deflection and vibration during AHU operation. Manufacturer shall provide suitable stiffening by means of box type members across the same. AHU shall be with clean inside surfaces with beveled corners to the best possible extent without crevices as may allow growth of algae / fungus. In case on internal fittings such as dampers, the same shall be with beveled edges and without sharp corners to prevent operator injury. There shall be no screws projecting into AHU or air stream. If the same is unavoidable, the tips shall be fitted with rubber caps to prevent operator injury.
AHU panels shall be factory fitted with pressure ports for DPT installation. The number and size of these shall be confirmed in the AHU technical approval stage. In case opening is to be made in AHU panel, the same shall be with C-channel all around to prevent entry of PUF into air stream. The channels shall be cut at 45 degrees at the corners to avoid overlap. Material for the channel shall be same as that of internal skin of AHU.

Rubber grommets shall be provided at all entry points into AHU such as coil connection, cable entry etc. The same shall be double lip tight fitting to prevent air leakage.

All access doors shall be outward opening. For doors provided downstream of the fan, especially in high static AHUs, additional clamps shall be provided along periphery of door to maintain constant pressure and ensure proper sealing.

7.5 THERMAL BREAK PROFILE

AHU’s such as TFA units, AHU with mixing box having return air ducted shall be provided with thermal break profile as indicated in schedule of quantities. Also these AHU’s shall be provided with 46 mm thick panel. Panels and thermal break profiles for all AHUs shall be designed and assembled in such a way that there shall not be any condensation on AHU with conditions of 35°C and 92% RH (AHU surrounding conditions) at designed operating conditions inside the AHU.

7.6 DAMPER

Dampers shall be opposed blade type. Blades shall be made of double skinned aerofoil aluminium sections with integral gasket and assembled within a rigid extruded aluminium alloy frame. All linkages and supporting spindles shall be made of aluminium or nylon, turning in teflon bushes. Manual dampers shall be provided with a bakelite knob for locking the damper blades in position. Linkages shall be extended wherever specified for motorised operation. Damper frames shall be sectionalised to minimise blade warping. Air leakage through dampers when in the closed position shall not exceed 1.5% of the maximum design air volume flow rate at the maximum design air total pressure.

7.7 MOTOR AND DRIVE

Fan motors shall be energy efficient (EFF-1) and shall be 415±10% volts, 50 cycles, three phase, totally enclosed fan-cooled class F, with IP-55 protection. Motors shall be especially designed for quiet operation and motor speed shall not exceed 1440 rpm. Drive to fan shall be provided through belt-drive arrangement. Belts shall be of the oil-resistant type. For three stage filtration AHUs, belt drive shall not be used and direct driven plug fans shall be used.

7.8 FAN

Fans shall be centrifugal, forward curved / backward curved / aerofoil so as to give maximum efficiency for given duty condition. Fans driven by variable frequency drive shall be backward inclined irrespective of static pressure value. Fans shall be selected for minimum efficiency of 75% Fan casing shall be made of galvanized steel sheet. Fan wheels shall be made of galvanised steel. Fan shaft shall be grounded C40 carbon steel and supported in self-aligning plummer block operating less than 75% of first critical speed, grease lubricated bearings. Fan wheels and pulleys shall be individually tested and precision balanced dynamically. Fan motor assembly shall be statically and dynamically balanced to
G6.3 grade as per relevant ISO/AMCA standard. Computerized fan selection print outs shall be submitted along with the offer.

Motors shall be mounted inside the AHU casing on slide rails for easy belt tensioning, and be totally enclosed, fan cooled, to be class ‘F’ insulation. Motors shall drive heavy duty V-belt, constant pitch, drive selected at 110% of motor horsepower.

Both fan and motors assemblies shall be mounted on a deep section aluminium alloy or galvanised steel (depending on size) base frame.

Combination spring and rubber anti vibration mounts shall be provided for isolating the unit casing. Frame retardant, waterproof silicone rubber impregnated flexible connection shall be provided at the fan discharge.

7.9 COOLING COILS

DX coils shall have 12.5 to 15 mm dia (O.D.) tubes minimum 0.4 mm thick with sine wave aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and such that the air velocity across the coil shall not exceed 150 meters per minute.

The coil shall be pitched in the unit casing for proper drainage. The coil shall have copper header with chilled water supply & return connections protruding out of AHU casing by minimum 150 mm and fitted with dielectric coupling for connection with MS pipes. Each coil shall be factory-tested at 21 kgpersq.m air pressure under water. Tubes shall be hydraulically/mechanically expanded for minimum thermal contact resistance within fins. Fin spacing shall be 4 - 5 fins per cm. Water pressure drop in coil shall not exceed 10 PSIG.

Coils shall be provided with mechanical means to purge air from the coil during commissioning by means of a purge valve or nipple. To prevent splashing, discharge from the same shall be routed to the condensate drain pan by means of flexible PVC tubing of suitable diameter. Purge valve / nipple shall be accessible externally or by removal of blanking panel.

TFA AHU’s shall be provided with minimum 8 row cooling coil. TFA units which receives pre-cooled fresh air can be provided with 6 row deep coil upon verification of coil selection output. Reheat coil may be provided if indicated in Schedule of Quantities. Reheat coil shall be 2 row deep and shall be of same construction as above. In case AHU has multiple coil stacked one above another, intermediate train of SS 304 (18 gauge) shall be provided so that upper level of coil drains into this train. Copper / SS 304 piping shall be provided from this train upto main bottom tray. Computerized cooling coil selection output shall be submitted. Coil rating shall be as per ARI-410/2006.

7.10 ACCESSORIES

Each air handling unit shall be provided with manual air vent at high point in the cooling coil and drain plug in the bottom of the coil. In addition, the following accessories may be required at air handling units, their detailed specifications are given in individual sections & quantities separately identified in schedule of Quantities.

a. Water resistance marine light with power cabling.
B. Minimum 2 Nos nameplates (1 in etched metal and other plastic) mounted onto AHU panel with suitable water-resistant adhesive along with relevant warning stickers on various panels. The nameplate shall give all relevant details including fan model selected, motor KW, Air quantity and total static pressure.

7.11 ISOLATORS

Vibration isolators shall be provided with all air handling units. Vibration isolators shall be cushy foot mounting type. Minimum vibration isolation efficiency shall be 90%.

7.12 PAINTING

Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with paint to match the finish over the adjoining shop painted surface.

7.13 PERFORMANCE DATA

Air handling unit shall be selected for the lowest operating noise level of the equipment. Fan performance rating and power consumption data, with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the installation.

7.14 TESTING

Cooling capacity of various air handling unit models 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. Power consumption shall be computed from measurements of incoming voltage and input current.